

Using Technology to Increase Learning and Decrease Costs in a Computer Fluency Course

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Abstract: While many uses of technology in teaching/learning result in added costs, the goal of the Pew Learning and Technology Program (PLTP) is to demonstrate uses of technology that both increase learning and decrease costs. By analyzing the full costs both a traditionally taught course and a restructured version of the course it is possible to determine what the added costs or the cost savings are for a contemplated change in course structure. Presented here are the preliminary results of one program project funded by PLTP: the redesign of a large enrollment, freshman computer fluency course.

Through discussions about technology, learning and costs, a faculty team developed a new course structure that: reduces the number of lecture hours; increases the time students spend in small lab sections; doubles the number of student assistants in each lab section; provides multiple means for students to learn course concepts through the use of web-based and CD-ROM based interactive learning materials; provides short video clips of experts presenting essential course material; and utilizes a web-based course management system. We predict that learning will be increased as a result of the new course structure. In terms of cost, the plan indicates that the per student cost of the course will drop from \$248 to \$114 if the enrollment remains constant. If the enrollment grows as predicted the per student cost would drop to \$99.

The methodology of course redesign and cost analysis used here would be applicable to any engineering course. One advantage of this methodology is that it enables professors to quantitatively measure the cost consequences of a course restructuring. But the main advantage comes from simply engaging in the consideration of both pedagogical desires and costs. Through such discussions, creative solutions and new pedagogical strategies can arise. Most importantly, this process helps us as professors to articulate our educational goals and to clearly demonstrate what is crucially important in the face-to-face instruction we provide.

Keywords: computer fluency, educational technology, web-based pedagogy

1. Introduction

As participants in the Pew Learning and Technology Program [1], we have redesigned a large-enrollment, freshman-level computer fluency course for non-majors, with the goal of using technology to increase learning while at the same time decreasing costs. Some faculty members are threatened by such goals as they fear that the way to achieve the goals is to replace faculty with technology – to replace live lectures and discussions with videotapes of lectures and automated on-line tutorials. Our course redesign team took a different approach as we wanted to increase the face-to-face interactions between the students and the faculty and other course staff. The redesign motive comes from the course team's observation of several successful implementations of technology-mediated instruction, especially the math emporium at Virginia Tech [2] and the studio model at RPI [3]. Both of these implementations involved a significant redesign of both the physical and the curricular learning environments. The physical redesign

was possible at Virginia Tech because of an “emporium tax” imposed on other units in the institution, while at RPI the physical redesign was coordinated with a general plan for building rehabilitation. Most institutions probably do not have the opportunity for such significant space alterations. Even when sufficient financing is available on a selective basis, it may not be possible to support such a revision of all large-enrollment courses. Our course team was therefore interested in a redesign that addressed the curricular learning environment while utilizing the *existing* physical learning environment. Although the results may not be as dramatic as in the case of major space redesign, the resulting model could be more widely replicable at other institutions.

The redesigned course will provide multiple means for achieving the learning outcomes. Lectures will be de-emphasized and proportionally replaced by web-based active learning material, thereby reducing the number of faculty contact hours. Short individual projects will be supplemented with multi-week group projects that incorporate collaborative learning. The use of on-line computer-graded diagnostic pre-quizzes, quizzes and exams will facilitate learning and increase faculty productivity.

2. Traditional Course Environment

CSE 101 is a computer fluency course with an annual enrollment of approximately 1000 students. The goal of the course is to educate students about technology in general and about computers in particular. While students learn some basic skills, such as how to use a word processor and a spreadsheet, they are also taught the concepts underlying the skills. This enables the students to develop capabilities on their own to cope with technology and its changes.

The primary goal of the course is to enable students to become fluent in the basics of information technology that are essential for:

- Being productive as a student;
- Being productive in the workplace;
- Being an informed citizen; and,
- Applying IT to personally relevant tasks.

The course is taught in large lecture sections of approximately 200 students each that meet for three hours a week over a 15-week semester. In addition to the lecture, the students have two hours of formal lab and two hours of open lab time per week. The labs are held in a 27-station departmental computer lab dedicated to CSE 101 for fifty hours a week. Maintenance and staffing of the lab for these hours are included in both the traditional and the redesigned analyses.

A full-time non-tenure track faculty member teaches two sections per semester of the course, while a temporary lecturer covers the third section each semester.

Seven Graduate Teaching Assistants (GTAs) teach the lab sections. They also help to staff the lab during open lab hours by holding their office hours in the lab.

Undergraduate students are paid at an hourly rate to staff the lab during the rest of the open lab hours.

Four undergraduate lab assistants maintain the lab under the supervision of the departmental Director of Laboratories.

3. Learning Goals and Objectives for the Redesigned Environment

The redesign is based on the learning outcomes for computer literacy courses presented in the NRC and NSF sponsored report “Be FIT: Fluency in Information Technology” [4]. (The course team followed the development of the report over the past years and saw no need to reinvent the wheel by creating a different set of learning outcomes.) The report states that students need to learn three kinds of knowledge that are interdependent and co-equal:

- Concepts -- understanding the foundations of information technology;

- Skills -- knowing contemporary applications; and,
- Capabilities -- higher level thinking applied to information technology.

Within each knowledge component there are ten particular learning outcomes specified by the report, which became the learning goals of the redesigned course.

4. Cost Analysis Techniques

The Pew Learning and Technology Program provided the course redesign team with a cost analysis tool that consisted of a set of spreadsheets and instructions. Hourly pay rates were determined for all of the faculty and staff associated with the traditional course. The number of hours that each faculty and staff member spent in each of about twenty specific activities associated with the course over the course of one semester were estimated. Thus the total personnel costs for the traditional course were determined. The costs for the redesigned course were determined using the same techniques [5].

An important issue in deciding to redesign a course in terms of both learning and costs concerns how the cost savings are realized and distributed. If all of the cost savings were to be kept by the central administration of a university, then faculty would not be motivated to consider costs in course redesign. In our case some of the cost savings is in terms of faculty time. Thus faculty will be able to spend less of their time on the uninteresting portions of teaching (i.e. grade recording) and thus spend more of their time on research or other teaching activities. This faculty time savings is thus not a cost savings that the university can actually see. But the other cost savings in terms of personnel are actual dollar savings, which will be divided between the department and the dean.

At the outset the course team believed that it would be possible to improve the student learning in the course through the addition of supplemental technology-based activities, but only by increasing the cost of the course. By adding the constraint that the costs had to decrease, we were forced to think about completely different ways of teaching the course. This took us out of our standard ways of operating and pushed us into a new creative space. We began to look at different models of educational technology use, and rejected many on pedagogical grounds. We reexamined what we believed were the crucial components of the way we taught and students learned, and determined what needed to be preserved and enhanced to improve the pedagogy [6].

5. Plan for Redesign

As a computer fluency course, it is particularly challenging to increase learning and reduce costs through the use of technology, since the majority of the entering students are not sufficiently comfortable with technology to be able initially to replace face-to-face contact with web-based materials. The proposed solution is to increase the face-to-face personal assistance available to students through the use of Undergraduate Learning Assistants (ULAs).

The redesign will offer a flexible learning environment that will allow self-motivated students to advance at their own pace through the course. At the same time, a highly structured learning experience will be provided for students who require clearly spelled-out expectations to be met at regular intervals.

The preliminary ideas for the course redesign include:

- a) Decrease the number of lectures from three to two per week. This will be possible through the following changes.
 - Web-based active learning tutorials developed by textbook publishers, by faculty at other universities, and by commercial vendors will provide students with alternative ways of learning some of the material previously covered in lectures.
 - Diagnostic on-line pre-quizzes will provide students with another learning tool--students must pass a pre-quiz before being allowed to take a quiz for a grade. The quizzes will be diagnostic, providing feedback as to which topics need to be further studied to master the material, and will provide pointers to the location of course materials relevant to the specified topics.

- Short mini-lectures on selected topics that are unlikely to change much over a period of several years, and that students find most difficult, will be made available to students on CD-ROM or on the web.
- b) Improve learning through the use of CSCL (computer supported collaborative learning) group activities (both web based and lab based).
- Short, individual projects will be supplemented with multi-week group projects, allowing for collaborative learning and the opportunity to integrate a broader range of concepts, skills and capabilities.
- c) Replace the GTAs with ULAs.
- Many of the GTAs currently used for CSE 101 are not native English speakers and often find it difficult to communicate with computer literacy students. We have used a small number of ULAs in the past and have found them to be very effective. But since we do not allow them to grade other undergraduates, we have been unable to completely replace the GTAs. By replacing our paper and pencil quizzes and exams with automatically-graded on-line quizzes and exams (except for a few essay questions), we will be able to completely replace the GTAs. (The replaced GTAs will be used in advanced Computer Science courses where their technical expertise can be more successfully utilized, and where increasing enrollments are generating demand for additional GTAs.)
- d) Increase individualized assistance and transition during the semester from a predominantly face-to-face environment to more of an on-line environment.
- The overall goal is to provide much more individualized support than is available in the traditional course.
 - Many of the students in CSE 101 have little or no computer experience. It is therefore not possible to jump right in using web-based materials as may be possible in many courses. At the beginning of each semester, there will be more formal lab hours and fewer open hours, while at the end of the course there will be more open lab hours available and fewer formal labs. Similarly, personal assistance will at first be available primarily in face-to-face form, while by the end of the semester more on-line personal assistance will be available. In general, more ULA hours will be available at the beginning of the semester than at the end. (This redesign fits in with the schedule of the typical undergraduate who has more time available at the beginning of the semester and less at the end.)
- e) Use more effective technical support for the course and the lab.
- One side effect of doing the cost analysis of the traditional course was the realization that the way we have been providing technical support is problematic. Advanced staff have been providing excessive hours because their expertise is in Unix-based systems and they have little NT expertise. We are also using excessive undergraduate hours in an ineffective manner. The proposed solution is to hire a less expensive staff person with technical expertise in NT and to decrease undergraduate hours by automating software installation, etc.
- f) Lighten the faculty member's workload through the use of a course management system (such as WebCT or BlackBoard) and on-line testing.

6. Implementation

The redesigned course will be implemented in the fall of 2000. We have collected survey and focus group data on the traditional course during the Fall 1999 and Spring 2000 semesters. We will collect the same data for the redesigned course during the next academic year. A comparison of the data will be used to assess the success of the course redesign from the student learning point of view.

The cost analysis of the redesigned course versus the traditional course already indicates significant cost savings. The plan indicates that the per student cost of the course will drop from \$248 to \$114 if the enrollment remains constant. If the enrollment grows as predicted the per student cost would drop to \$99.

7. Conclusions

By considering both the pedagogical and the cost constraints of the course design, the course team was able to arrive at a new course design that should improve student learning while at the same time reducing costs. This exercise in course redesign has enabled the members of the course team to develop new skills in analyzing and redesigning courses. These skills will transfer to other courses taught by each member of the team. In addition, if the redesigned course does prove to be successful in increasing student learning, then the course will serve as a model that other faculty at our institution and faculty from other institutions can use for the redesign of their courses.

8. References

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