

Using Self-Paced Learning to Personalize Engineering Education

Christi L. Patton
The University of Tulsa

Abstract

As class sizes in the freshman chemical engineering class outgrew the available rooms and one teacher's ability to safely manage hands-on design projects, a new class management philosophy was needed. Two hours of this three-hour course were conducted electronically. Students met in a classroom with one-third of the group for the remaining one-hour-per-week lecture. Blackboard Learning System – Vista Enterprise was used to post video lectures and manage quizzes and homework assignments. This paper presents the details of management of this class and the highlights of what did and didn't work.

Background

Degrees conferred from chemical engineering programs across the U.S. declined 34% between 1997 and 2006¹ and The University of Tulsa (TU) has mirrored this trend. This same period of time saw significant changes in the technology infrastructure at TU in the College of Engineering and Natural Sciences. Every classroom was equipped with a computer console and display for instruction. All engineering departments established computer laboratories for their students in addition to the numerous facilities available to all students. WiFi was installed campus-wide. Two instructional laboratories were created with computers for up to 30 students.

In 2007 and 2008, the public has watched the price for a barrel of oil rise to unprecedented levels. Salaries have skyrocketed for engineers prepared to work in the petroleum industry. At TU, the enrollment of new students in petroleum-related fields is on the rise. The chemical engineering department has benefitted from this, with enrollment of new students in the ChE program increasing nearly 50% from 2006 to 2007 (and a projected increase of 100% from 2006 to 2008). While increasing enrollments are good for the university, they have also created a host of new problems relating to space and equipment limitations. Classrooms are at capacity during the most popular time slots. The computer instructional laboratories can no longer accommodate a full class. Instructors, accustomed to small, intimate classes in which they were able to learn every student's name within the first week, face significantly larger groups. Students can easily slip into anonymity.

In the past decade, teachers have incorporated more active-learning activities and hands-on design projects. In particular, the freshman-level courses benefited from this philosophy change. At the University of Tulsa, freshmen select a major as they enter the university. The introductory classes are discipline-specific and each department teaches their own freshmen. In chemical engineering, the freshman year has a two-course sequence. ChE 1002 is a two-hour course taught in the fall semester to introduce students to the career and to ensure they have the necessary background skills (unit conversions, graphing, etc.). ChE 1013 is a three-hour course taught in the spring semester. The students learn to program with Excel and VBA and use these

skills in a design project and related competition. The design project varies from year to year, but always involves student design and execution of their own experiments to control a chemical reaction for the specified purpose. This is potentially chaotic, but small class sizes enable a professor to manage this in a safe manner that is beneficial to the student. In 2008, the enrollment in ChE 1013 exceeded the space available in the largest computer classroom. The instructor could not safely manage the design project and experimentation, and no additional professors were available to open a new section. A new class management philosophy was required.

A New Plan

The ChE 1013 course was reorganized for 2008 in order to allow smaller class sizes without increasing teaching load. The course was divided into two distinct components: one hour per week of classroom instruction and two hours per week of self-paced electronic instruction. The students were divided into three groups of 11 or 12 which each met once per week for 50 minutes during one of the original designated class times. This time was used for the design component of the class and for student presentations. The remaining two-thirds of the course was conducted online using Blackboard Learning System – Vista Enterprise (Vista). This portion of the course focused on programming with Excel and with VBA. These programming skills were used in the design project and allowed opportunities for discussion within smaller groups of students. The remainder of this paper will focus on the self-paced portion of the course.

All TU students have access to Vista. Most teachers use this as a repository of handouts and course supplements, or to post grades throughout the semester. However, it has many additional capabilities and is designed to manage entire online courses or as a supplement to more traditional courses. For ChE 1013, the instructor created 26 modules incorporating (1) videotaped lessons, (2) links to supplemental online materials, (3) online quizzes, and (4) homework assignments. Each lesson had a due date. After the due date, students could complete the work with a 2% per day penalty.

The videotaped lessons were created using TechSmith's Camtasia Studios. Camtasia is a relatively inexpensive screen recording software. Input from a video camera, background music, title screens, and more can easily be added. Using a microphone, the instructor can talk the students through the material, allowing for both audio and visual instruction. Although files may be produced in one or more format, students at TU seem to prefer flash files and podcasts. In this course, videos were produced as Flash SWF files. Some lessons were recorded at the university while others were recorded from the instructor's home. Traditional fifty minute lectures can be reduced twenty to thirty minutes on video without compromising content.

Each lesson included an electronic assignment and quiz, composed primarily of multiple choice, matching, and true-false questions. Some open-ended calculations and short answer questions were used. There were multiple versions of each quiz to minimize collaboration. Additionally, all quizzes were set up for automatic grading and were submitted through Vista. Occasionally, students turned in hand-written work, and a scanner was made available in the student computer laboratories. These assignments were graded by the professor. To hold these technically savvy

students accountable for their work, students were given an in-class midterm exam and final exam over the material provided electronically.

Student Reactions

Course assessments indicated that students felt very positively about the format of this course. Since they still had class time with the instructor, students did not feel anonymous. Students retained professor-pupil relationships. Occasionally technical problems arose, but after student report, were corrected within one day. Additionally, several students reported they had saved copies of all the instructor's videos, and a few asked for a DVD copy for later review.

Students enjoyed the advantage of going through each lesson at their own pace. Although background and familiarity with Excel varied greatly from student to student, some found that they could go through most lessons without pausing, while some found the lessons more challenging. On those lessons, students found it beneficial to pause or repeat portions of the video recording. Most students did the lessons from home, and those without reliable internet access did the lessons on university computers. These students brought their own headphones in order to complete their lessons without disturbing other in the campus laboratories.

However, there were disadvantages for the students. The biggest difficulties seemed to arise from poor time management and study habits. A significant number of students (23%) procrastinated until the instructor's final call for on-time assignments. Several of these students in fact watched the video lessons in a timely manner, but avoided the quizzes and assignments until faced with a firm deadline. For these students, the two-point penalty did not seem to provide adequate motivation to complete work on time. The majority of these students expressed contentment in the freedom of pacing of the course, regardless of point losses. When students had questions after university hours, they had several options. They could post them to the class through a discussion board, email them to the instructor, or wait until the next day's office hours or next class session. However, none of the available options provided immediate feedback.

Instructor's Reaction

From the instructor's point of view, the experience was very positive. Despite the reduced in-class hours, meeting in small groups provided a tremendous opportunity for student interaction. Managing the design project in smaller student groups was decidedly beneficial.

Creating material for the electronic portion of the course was more time-consuming than preparing material for the traditional course, partly due to the learning curve associated with these software packages. Editing the videos for professionalism proved difficult, time-consuming, and ineffective. In time, editing lost priority and the unedited lessons remained intact, despite occasional background chatter. Students sometimes commented on the occasional dog barking or phone ringing, but this mostly served to reassure that the students were, in fact, watching the lessons. Based on the opinions of those who expressed them for the class, the casualness of the unedited videos felt more like being in class.

One significant benefit of having these lessons pre-assembled is that they are available for future students to access. For example, transfer students that needed to learn the material prior to their enrollment in the fall of 2008 were able to use these lessons as an independent study. Many of these videos will be re-used in the spring of 2008, with updates compatible to TU's software changes.

Because the instructor was allowed to prepare lectures on an unstructured time-table, they could be prepared at home, at odd hours, and without regard for proper attire. Although it could be difficult to feel motivated to provide an energetic lecture without an audience, bad lectures were easily replaced.

Recommendations for the Future

Enrollment figures for the 2008-2009 school year show that class sizes continue to increase. Because the student response was generally very positive, this format, with modifications, will again be used. The instructor will continue to hold normal office hours, but will include one or two hours per week of online office hours later in the evening using the Vista chat tool. Student performance on in-class exams will dictate changes that will be made to online lectures. The deadlines, and resultant point penalties, will be altered to provide additional incentive for appropriate time management.

Bibliography

1. U.S. Department of Education, National Center for Education Statistics, Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1970 – 71 through 1985-86; and 1986-87 through 2005-06 Integrated Postsecondary Education Data Systems, "Completions Survey" (IPEDS-C:87-99), and Fall 2000 through Fall 2006. http://nces.ed.gov/programs/digest/2007/menu_tables.asp. Table prepared June 2007.

Biographical Information

CHRISTI L. PATTON

Dr. Patton earned a B.S. in Chemical Engineering from Texas A&M University, a M.S. in Applied Mathematics from The University of Tulsa and a Ph.D. in Chemical Engineering from The University of Tulsa. Currently she is Applied Associate Professor of Chemical Engineering at the University of Tulsa. She directs many interdisciplinary design projects through the Chemical Engineering department and Engineers Without Borders.