AC 2010-865: CONVERTING EXISTING LECTURE COURSES TO DISTANCE LEARNING

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Converting Existing Lecture Courses to Distance Learning

Abstract

Increased enrollments, constrained budgets, and reductions in full-time faculty present new challenges for engineering departments. Contingent faculty (adjuncts and other part-time appointments) are increasingly recruited to staff critical courses. However, conflicting class and personnel schedules are a real barrier to maintaining high quality instruction. Blended learning structures offer a solution to this problem.

At our university the course Chemical Materials Science is usually taught as a traditional lecture course which meets 4 days per week. During the Fall 2008 quarter, the course was taught in a blended lecture/distance learning format. This format, formed to accommodate the schedule of the available adjunct instructor, met once per week for a lecture/discussion session. The remainder of the course information was presented via recorded online lectures and other online features via the Blackboard™ website system. Blended learning classes are fairly new to engineering, and in fact this was the first time any ChE course at this university was taught with an online component. Because of this we gathered information to determine both student perceptions of the amount of work involved, and instructor perceptions of the amount of extra preparation time. The course was received reasonably well by the students, although most would prefer more face-to-face interaction with the instructor. Recorded lectures in Interwise™, as well as organized and consistent information for the course topics were found to be very useful to the students. Other online tools such as discussion questions received mixed response from the students. Although there was a great deal of online administration necessary, it did not take an excessive amount of time to adapt an already existing course to this format. Students who actively engaged in the online activities such as a discussion board, the creation of group Wiki based reports, and 'Concept Check' quizzes performed better on exams, and had higher final grades than those who relied more on homework and the single weekly lecture to learn the material. The average overall course grade was 85%, which is comparable to similar classes taught in the traditional style. These results indicate that well-designed blended learning courses can accommodate scheduling issues, provide high-quality learning environments, and produce acceptable student learning outcomes compared to traditional face-to-face courses.

Introduction

Chemical Materials Science is typically taught as a 4 lecture per week course. Student performance is evaluated via weekly homework and 2-3 exams per quarter. Past offerings of this and other similar materials science courses have included features such as lab experiments and open ended materials selection projects done in groups. These group projects typically involved written and/or oral reports in order to improve soft skills and allow promotive interaction between the students. Collaborative learning has been a key feature of many courses at our university, and has been used extensively in other materials science courses.[1]

In the past this course has been taught either by a full time faculty member, or by an adjunct able to teach the class in the standard format. In the Fall 2008 quarter, neither a full time faculty member nor the usual adjunct were available to teach the course. An adjunct was found who had taught similar courses numerous times, and who was eager to teach the course. Unfortunately, due to the adjunct's previous commitments and difficulties with scheduling classroom space, the traditional 4 lecture format proved to be impossible from a logistics standpoint.

Our university has been moving toward increasing the number of distance learning courses, in an effort to reach more students and as a way to reconcile larger numbers of students with limited classroom space. The decision was made to adapt this course to a blended lecture/distance learning format. This would allow the adjunct to be physically on campus only one day per week for lecture and office hours. This format also solved the problem of reconciling numerous student schedules, preventing conflicts with other required classes.

The Chemical Engineering department had not attempted such a blended course before. This presented an excellent opportunity to gather data on student perceptions. This was accomplished via surveys of the students at several points throughout the course. Student outcomes were also compared to similar courses taught previously, in order to determine whether learning outcomes were affected by the change in format. Finally, the instructor kept track of time required to administer this course. If the course was found to be comparable to similar courses in terms of instructor time, more instructors might be encouraged to use this approach.

Course Features and Format

The content of the course was broken up into weekly topics and subtopics. The general outline of the course was as follows:

- Week 1: Structures
- Week 2: Crystallography and Mass Transport
- Week 3: Mechanical Behavior
- Week 4: Midterm Exam
- Week 5: Phase Behavior and Processing
- Week 6: Environmental Interactions
- Week 7: Final Exam

The topics were used as the organizational scheme for the website. A folder was set up in the Blackboard™ site for each week. The folder contained between 3 and 5 subtopics. Each subtopic was in the form of a 'Learning Unit', using the tool available in Blackboard™. This tool allows students to step through material sequentially, or to jump to the section required.

The Learning Unit for each subtopic contained the following items:

- **An introduction**: This outlined the instructional objectives for the subtopic.
- **A reading assignment**: This consisted of specific chapter sections of the textbook and/or other articles designed to provide the necessary information to understand the subtopic.
- **Concept Check quiz**: This was an online quiz designed to test whether the student had learned enough of the basic concepts to successfully attempt the homework assignment.
- **Additional information**: If the student did not understand all the concept check questions, or had additional questions, there were links to PowerPoint presentations, websites, videos, and other tools to help explain the concepts.
- **Homework questions**: One homework assignment was turned in per week, consisting of 1-2 questions from each of the subtopics for that week.
- **Discussion questions**: There were required, open ended problems that were discussed on the class discussion forum. Every student was required to post at least 1 substantial response to each mandatory discussion question. Further discussion contributions counted toward the participation portion of the grade.

Although much of the content is similar or identical to that used for a traditional course, there were a few specific online tools that were used to promote student interaction and help guide student learning. The Concept Check quizzes gave the students immediate feedback on whether or not they understood the material. Students were allowed to take the quizzes up to 2 times. The quizzes gave specific feedback for wrong answers, letting the students know where to find the information they needed, without giving them the correct answer.

Another online tool specific to this course was the Discussion Forum. Because there was a limited amount of in-class time, required discussion questions were used to give the students a chance to interact with each other and with the professor. The questions, posed by the professor, were open ended. Often, they had to do with ‘gray areas’ of materials – ethics, recycling, the pros and cons of changing from one material to another, etc. Other questions required students to research a certain topic, and provide links to information that they found interesting or helpful.

A portion of the grade for the course was based on an open ended group project. Each group had an open ended design question to research and answer, with an emphasis on material selection. Normally, student groups would present their solution to such a problem in front of the class. However, due to the limited class time available, it was not possible to have oral presentations. Instead, the Blackboard™ wiki tool was used as the platform for the students to present their work. Other students could see what the other groups were doing, leave comments, and exchange ideas. It was possible to keep track of individual contributions to the group projects, as the wiki

tool notes who contributes to or edits each page of the wiki. While the projects were in the development stage, comments could be left by the professor in order to encourage or guide the students as needed. Grading was accomplished by adding a page with feedback and the final grade to the wiki for each group.

Interwise™ conferencing software was used in order to facilitate the need for interaction with the professor. Standing 'Virtual Office Hours' were scheduled, where students could log into Interwise™ and interact with the instructor and other students. Interwise™ was also used as a tool to record lectures, where PowerPoint slides could be annotated and the instructor's discussion of the material could be heard by the students at convenient times. Interwise™ was also used as a means for holding exam review sessions at mutually convenient times, without requiring classroom space.

Student Perceptions and Feedback

The students were asked to fill out three surveys: a Pre-Class Survey, a Midterm Survey, and a Post-Class Survey. The Pre-Class survey was designed to determine the prevalent learning styles[2] in the class, as well as to gain information on their attitudes toward and expectations of the class. The Midterm survey allowed the students to give students a chance to provide feedback to the instructor on what was and was not working in the class. The Post-Class survey assessed students' perceptions of the course after the fact, as well as soliciting suggestions for changes to future courses.

The Pre-Class survey questions are listed in the Appendix. This survey was taken by 15 of the 16 registered students. Figure 1 shows the makeup of the class in terms of learning styles. The class as a whole tended toward the reflective dimension, meaning that independent work should not be a problem. However, the large amount of material to be absorbed by the students from class to class does require discipline. Students were similarly slanted toward the intuitive dimension more than toward the sensing dimension. This could have potentially caused some difficulties, as some of the concepts in this class do respond to memorization, and repetitive 'plug and chug' type of problems. The students were very strongly pulled toward the visual dimension. This is an area where an online course can be a great benefit, as it is easy to link to videos, interactive graphics, and a wide variety of other visual media for the visual learner. Finally, the students tended to be highly sequential, rather than global, learners. This fit very well with the step-by-step structure in which the various topics were laid out.

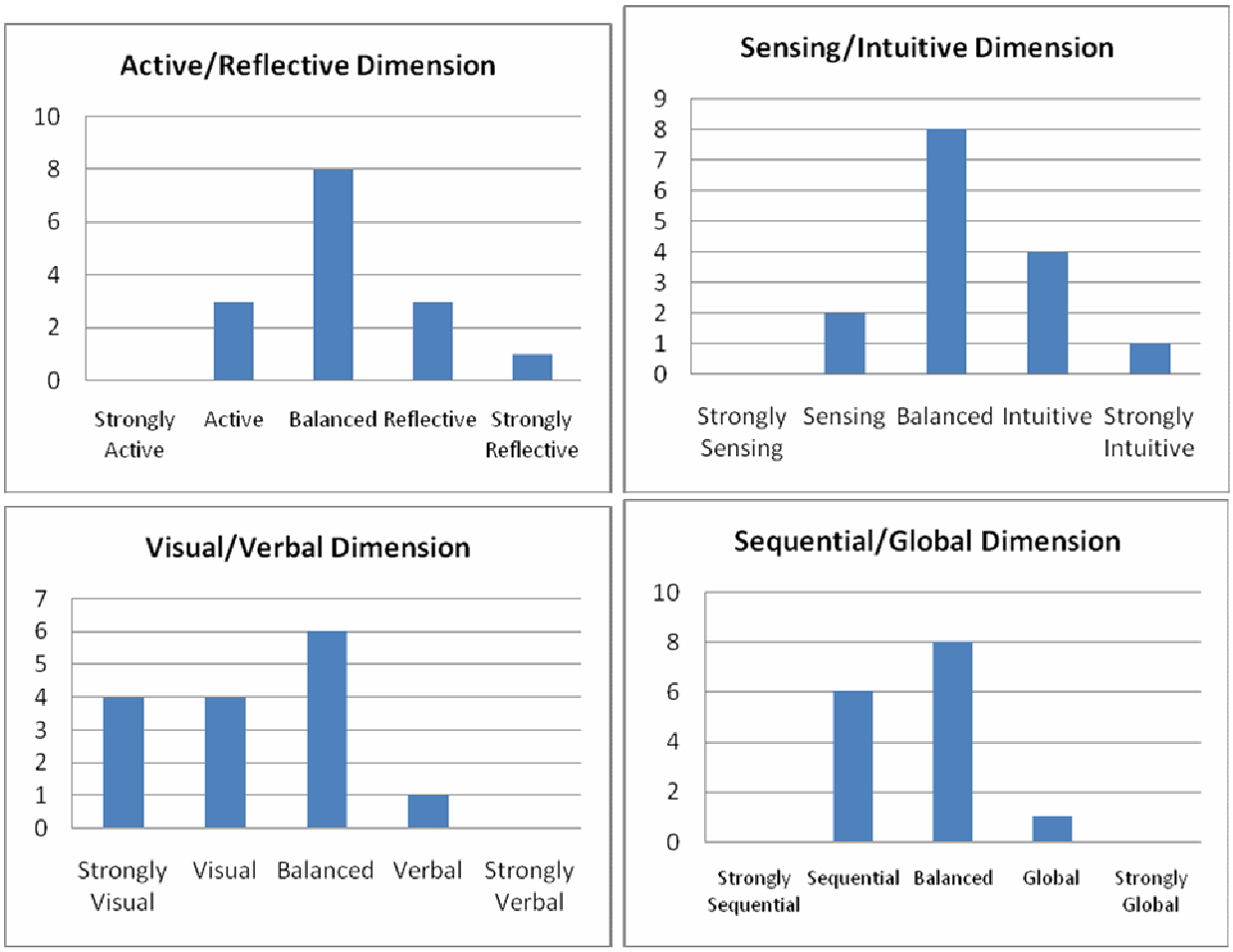

Figure 1: Results from survey of student learning styles

Several other interesting observations could be made from the Pre-Class survey. Figure 2 shows the results for two questions which asked the students' opinions on how comfortable they felt about online interactions. In general, students tended to be quite comfortable with the idea of interacting with their peers on line. However, there were a few students who were uncomfortable with the idea of interacting with a professor online. This indicates that although the students do tend to spend a lot of time interacting with each other online, they may not immediately want to replace traditional face-to-face interaction with the professor with virtual interaction. In addition, students were asked if they thought this course would require more or less time than a traditional course. 60% of the students thought that this course would take more of their time, while 40% were not sure how much time it would take.

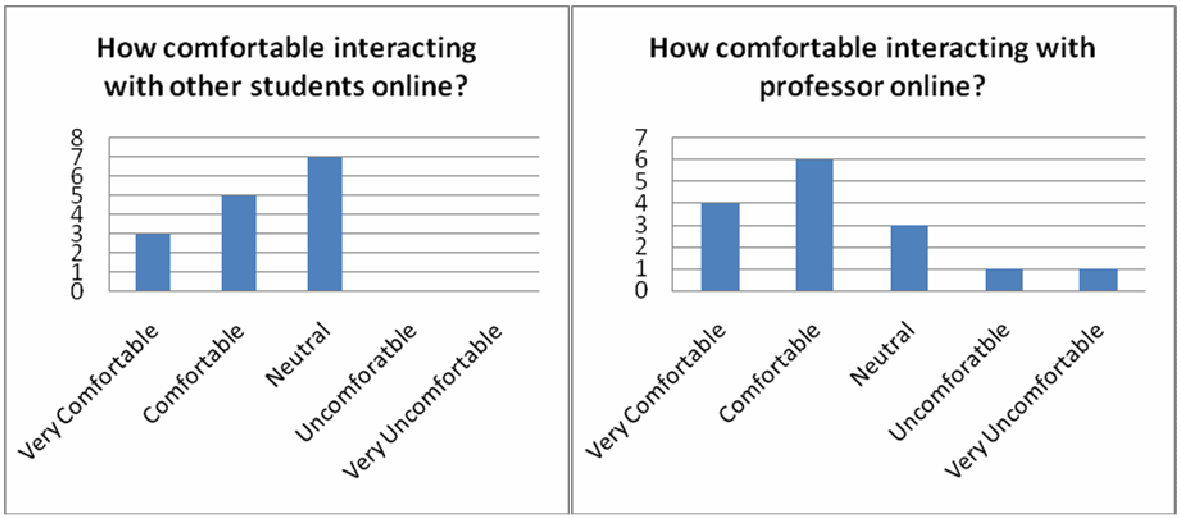

Figure 2: Results indicating student comfort with online interactions

The Midterm survey provided some useful feedback, which was used to make some mid-course changes in order to improve student learning. There were 10 respondents out of 16 students. Figure 3 below shows that students felt that, overall, the instructor was explaining things well, giving timely feedback, and provided a useful website. This gave some evidence that the lack of an on campus present was not preventing effective communication with the students. One disappointing result was that by the midpoint of the class, only 1 of the 16 students had used the virtual office hours via Interwise. In responding to the question "What prevents you from using virtual office hours?", 60% of the respondents cited inconvenient times, 30% said that they did not feel they need help, 30% felt they were uncomfortable with Interwise, 30% preferred email, and 30% had other reasons (students were able to choose multiple responses). Although effort had been made to schedule virtual office hours based on available times submitted by the students during the Pre-Class survey, these office hours were underutilized. In addition, students were encouraged to request additional office hours if needed, however no student took advantage of that offer.

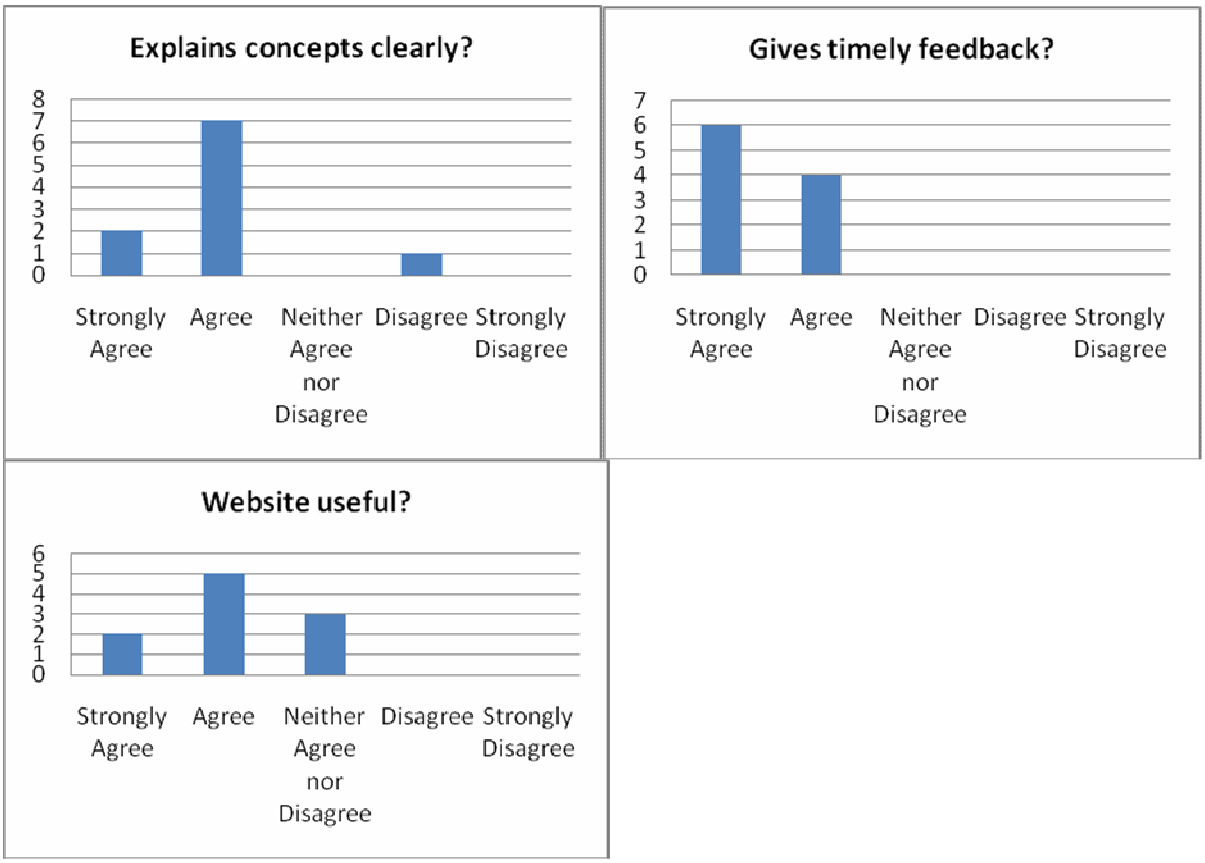

Figure 3: Results from Midterm Survey indicating effective communication

Responses to the question "Please describe one or two specific things that the instructor is doing that helps your learning in this course" reflected several common themes. Students appreciated the fact that the limited lecture time was spent on the most difficult topics.

The responses seem to verify the necessity for quick turnaround on email questions, as several students mentioned prompt replies as a key factor. The PowerPoint lecture notes and online quizzes were also very popular, as were the multiple sources of information. The responses underscored the importance of having information available on the website, well ahead of time, and in an organized fashion.

Responses to the question "Please describe one or two specific things that the instructor could do to improve your learning in this course." seemed to indicate a real need for additional class time. Students seem to feel that 1 hour a week was not enough time to cover the more difficult topics. There seemed to be a feeling that some of the updates to the website were not adequately communicated, and that more explanation of some topics was needed. Two suggestions from this survey were immediately implemented. First, any new announcements were accompanied by an email to the students. As the Announcements function in Blackboard has a checkbox for 'Email announcement to all users', this is a painless adjustment that ensured that students got important messages in a timely manner. In addition, the instructor began to use Interwise™ to record

lectures, based on the PowerPoint lecture notes already available. There was a very positive response to these recorded lectures, which provided a work-around for the limited class time.

The Post-Class survey was taken by only 4 of the 15 students, which makes it difficult to draw extensive conclusions. Of the 4 students who took the survey, all of them felt neutral, comfortable, or very comfortable with online interactions, whether with the students or the professor. Three students indicated that the course took the same time as a traditional course, while 1 thought it took more time. When asked if they would take a course with a similar format, 2 agreed, 1 was neutral, and 1 strongly disagreed. There was agreement or strong agreement that the professor was timely and helpful in responding to the student questions

Student responses to the question “What is one thing you liked about this course?” and to the question “What is one thing you would change about this course?” revealed common themes. Clearly, 2 hours a week of in class time would be preferable for this class, according to the students. One comment on the online discussion questions was particularly interesting, in that the students did not comment much during the course of the term about the discussion questions one way or another. The respondent wrote “Online discussion was useless. It had no educational value and seemed like busy work. Also, lectures weren't all that helpful since they were just a quick overview of what we were learning that week. I would prefer if Interwise sessions completely took over for lecture. Then in person class time was spent having discussions about the material (replacing the discussion board questions) and answering any questions the class had.” Students did provide the required discussion responses, but the discussions did not include a lot of interplay between the students. This aspect of the course should be reevaluated in future offerings.

Learning outcomes compared to traditional course

The instructor for this course has taught similar Materials Science courses at other universities in the past. The new format would be unacceptable if learning outcomes were vastly different between traditional lecture courses and the blended distance learning course. Table 1 below shows a comparison of the average final grade for a number of offerings of this course. In all cases the grading was done on an absolute scale (A >90%, B >80%, C >70%, D %>60, F <60%). All of the sections were taught by the same instructor, with the exception of the starred entry, which was taught as part of a two section offering of the course. The grades do not include students who ultimately dropped the course or received a grade of ‘No Record’. The students were all engineering undergrads, although many were mechanical engineers rather than chemical engineers. In addition, the courses taught at the other university included a lab component, rather than an open ended design project. The online quizzes, homework, and participation credit were similar, and the number of exams was the same. Although the final average was slightly lower in the distance learning offering, clearly there was not a large difference in outcomes.

Table 1: Comparison of final grades to traditional lecture courses

Term	Number of Students	Final Average
Spring 2005	63	89
Spring 2006	64	89
Spring 2007	70	89
Spring 2008	49	88
Spring 2008*	45	86
Fall 2008	12	85
Spring 2009	46	86

*Section taught by different instructor using same syllabus

In summary, student learning did not seem to suffer as a direct result of the course format. Although there were some initial concerns about the course, most students seem to have adapted to the format. Rapid instructor response is highly valued by the students, as is access to lecture notes that can be reviewed repeatedly. This fact could also be used to enhance traditional course, by providing online lecture notes and/or recordings of lectures. Finally, 1 hour a week of face-to-face lecture time is not enough to satisfy the students' needs for interaction with each other and with the professor, and future classes should incorporate at least 2 hours a week of in class time.

Instructor Workload

Preparing this course had two distinct challenges. First, the instructor had to take a course that she had previously taught over a 14 week semester and compress it into 7 weeks. In addition, the course had to move from a three or four lecture per week format to a one lecture per week plus online instruction format. The first challenge required adjusting expectations for the quantity and selection of topics covered. The second challenge required both innovative thinking about how to present the material, as well as learning the mechanics of administering an online class.

The adjunct instructor had taught a similar Introduction to Materials Science course at least once a year since 1998. Although this version had to be slightly tailored to fit the needs of chemical engineering students, it was by no means a new course. Although several topics were shortened, and some topics were left out, it was possible to cover nearly the same amount of material in the 7 week term as in the 14 week term. Topics deleted entirely were deemed of less importance to chemical engineers, and other topics were shortened by redirecting the focus toward materials of particular interest to chemical engineers.

When the instructor taught this course at another university, she used Blackboard™ extensively for online quizzes and to post homework assignments and lecture notes in PowerPoint format. Because of this, she already had a fairly extensive bank of PowerPoint lecture notes, quiz

questions, links to external websites, and lists of educational objectives for the various topics typically covered in the course. The initial generation of the PowerPoint slides, which was done several years ago, was rather time consuming, and took several hours per lecture. Although they were substantially complete, 30-60 minutes per lecture were required to double check the notes, fix things that had not worked in the past, and update dates and class titles. For an instructor who did not already have PowerPoint lecture notes, or some other electronic format notes, this would represent a large amount of prep time. Online quizzes can also take an hour each to input, although Blackboard™ tools can be used to speed up the process. Because the original online quizzes were not transferrable from the other university's Blackboard™ account, they needed to be reentered, which did take time.

Weekly administration of the course involved Interwise office hours, responding to student email, posting course material in the weekly topics, downloading quiz grades, and grading and responding to discussion questions. Interwise office hours were scheduled 3 hours per week, in addition to 1 hour per week of traditional office hours. Additional hour long exam review sessions were also held using Interwise. In the latter part of the course, due to lack of student participation, the instructor began to use these Interwise sessions to record lectures. If a student had logged on, she would have paused the recording or otherwise incorporated the student feedback into the recording as appropriate. However, this did not happen, so she was able to use otherwise unproductive time to best advantage. Responding to student email did not take up noticeably more time than in a traditional course. Uploading course material took anywhere from 4-8 hours per week, depending on the number of subtopics. Downloading quiz grades took almost no time, and was not a large chore. Discussion questions took 30-60 minutes per week to administer. Overall, the instructor spent slightly more time on this class than for a traditional class. However, as much of this work could be done at home, at convenient hours, it did not seem oppressive.

The key to technical success in this type of course was to use the available tools to the fullest. Blackboard has an incredible range of useful tools built into the software. The most important thing to consider when planning a course like this is to spend as much time as possible exploring all the capabilities of the tools. The available tools guided the selection of course activities to a large extent. In addition, our university has a well developed instructional technology center which was able to provide prompt technical assistance and advice whenever needed. Attempting such a course would be very difficult without this infrastructure.

Conclusions

Teaching this course was a very enlightening and rewarding experience. Any online course will have to work to provide sufficient interaction between the students and the instructor. Additional class time may be necessary, beyond what this course had, in order for students to perceive that they have 'enough' face time. Although students desired more face time, their learning did not seem to suffer greatly, and they were able to adapt. As with any course, the students need to feel

that the professor is responding to their questions, and that the professor is available as a resource.

Blackboard is a very powerful program, with many built in features which make developing this type of course relatively straightforward. There may be a learning curve associated with the various aspects of the program. However, professors in all courses, traditional and online, should be encouraged to explore the lesser used features, including Learning Units, Discussion Forums, and the Wiki tool. It is important to remember that whatever feature is used must be backed up by meaningful and well organized content.

This course took slightly more time outside of class than a traditional course. If a professor was teaching a brand new class, and teaching in the online format for the first time, the amount of upfront time could be extensive. It is encouraging to know that from the time the instructor learned about this course to the time it started, she had about two weeks to generate the format for the class and the online content. For a class with the content already prepared, this was not an impossible task. Adapting an existing course to this format should not be an insurmountable barrier, provided the instructor is willing to learn to use the required electronic tools.

Appendix: Survey Questions

Pre Class Survey Questions:

1. According to the Index of Learning Styles (ILS) what were your results in the Active/Reflective dimension?
2. According to the Index of Learning Styles (ILS) what were your results in the Sensing/Intuitive dimension?
3. According to the Index of Learning Styles (ILS) found at what were your results in the Visual/Verbal dimension?
4. According to the Index of Learning Styles (ILS) what were your results in the Sequential/Global dimension?
5. Please mark the times that you WOULD be available for extra online office hour sessions.
6. How comfortable do you feel with interacting with other students online?
7. How comfortable do you feel with interacting with the professor (for questions, explanations, office hours) online?
8. Rate how much time you expect to spend on this course, compared to a traditional course.

9. Please enter the name of the street you grew up on. This will be used to compare responses over time without identifying you personally

Questions 1-4 were based on a Likert type scale, ranging from “Strongly Active” to “Strongly Reflective”, etc. Choices for questions 6-7 were similar, ranging from “Very comfortable” to “Very Uncomfortable”

Midterm Survey Questions

1. The instructor explains important concepts clearly.
2. The instructor provides timely feedback
3. The course website is a useful source of information
4. Please describe one or two specific things that the instructor is doing that helps your learning in this course.
5. Please describe one or two specific things that the instructor could do to improve your learning in this course.
6. Have you used the virtual office hours?
7. What prevents you from using the virtual office hours? Check all that apply.
8. What, if anything, would improve the website?
9. Please enter the name of the street you grew up on.

Questions 1-3 had answers based on a Likert scale from “Strongly Agree” to “Strongly Disagree”

Post Class Survey Questions

1. How comfortable do you feel with interacting with other students online?
2. How comfortable do you feel with interacting with the professor (for questions, explanations, office hours) online?
3. Rate how much time you spent on this course, compared to a traditional course.
4. I would take a class in this format again if offered.
5. The material was challenging compared to other courses.
6. I was able to get the help I needed to understand the material.
7. The professor provided answers to questions in a timely manner.

8. What is one thing you liked about this course?
9. What is one thing you would change about this course?
10. Please enter the name of the street you grew up on.

Choices for questions 1-2 ranged from “Very comfortable” to “Very Uncomfortable”. Questions 4-7 had answers based on a Likert scale from “Strongly Agree” to “Strongly Disagree”

1. C. Demetry and J.E. Groccia, "A Comparative Assessment of Students' Experiences in Two Instructional Formats of an Introductory Materials Science Course," *Journal of Engineering Education* **86**[3], 203-210 (1997).
2. Richard Felder and Barbara Soloman, Learning Styles and Strategies, http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm, last accessed 11/6/08