

Use of Online Tools to Improve the Teaching of Graduate Courses in Chemical Engineering

Dana E. Knox

**Otto H. York Department of Chemical Engineering
New Jersey Institute of Technology
Newark, NJ 07102**

Abstract

Modern conveniences abound in the world today. This is sometimes not evident in graduate classrooms. While innovative teaching techniques are often discussed in regard to undergraduate courses, they seem to be less frequently seen in graduate courses. This is unfortunate, as these tools may in many cases be of even more value in those courses.

This paper will discuss the use of a variety of online tools in the teaching of the required graduate course in chemical engineering thermodynamics at New Jersey Institute of Technology. The tools include electronic lecture notes, online quizzes, web-based bulletin boards, electronic submission and grading of projects and papers, and online monitoring of course grades by the students. Use of these tools can help students whose learning style may not be well suited to the traditional lecture format. Many of these tools are also helpful in dealing with the diversity of backgrounds found in core graduate courses. Some differences are due to the educational background of the students. Others are due to their cultural background, as most graduate programs typically have many international students. Use of online tools can help to alleviate some of the problems in dealing with this diversity. There are also some pitfalls in using these tools that should be avoided. The paper will address both sides of the issue of using online tools to supplement the teaching of a required graduate course.

Introduction

Engineering graduate students represent a very different population from undergraduates. Classroom techniques and strategies that work well for undergraduates may not necessarily work as well for graduate students. It is widely recognized that the use of novel teaching techniques such as online tools can be very advantageous for undergraduate students. This paper will discuss how advantageous the approach was found to be for a graduate course in chemical engineering thermodynamics at New Jersey Institute of Technology.

What makes the graduate student population different? In most American engineering graduate schools, the most obvious difference is that the great majority of the students are international. American graduate students are definitely a minority in graduate school. Also, at least at New Jersey Institute of Technology, most of this minority are part-time graduate students working full-time and pursuing a Master of Science degree during the evening. With these two characteristics applying to more than 90% of the graduate student population, clear differences exist from the undergraduate student population.

Many online tools exist for improving the educational experience. Among the tools available at NJIT, and which were used for this course, are WebCT® and TurnItIn.com®. Previous authors have described how these tools are useful for undergraduate courses¹⁻¹². This paper will discuss how many of the features of WebCT make it particularly useful for improving the learning experience of graduate students.

Online Course Tools Used

WebCT is a course management tool that can be used as a delivery mechanism for distance learning, or to supplement a traditional course. Its many features include online delivery of course materials, course-specific chatrooms and e-mail, online submission of student work, online quizzes, and online grading which the students can access. Some of these features are also available via use of individual homepages, but some are not. Furthermore, since access to the WebCT site is password-protected it is much more secure than is use of a faculty homepage. TurnItIn.com is a website that allows faculty and students to verify the originality of submitted materials. Both of these tools have proven to be quite valuable in addressing some concerns that specifically apply to the teaching of the graduate student population.

WebCT¹³ is an acronym for Web Course Tools, a software package originally developed at the University of British Columbia. The package provides a convenient means for instructors to make available web-based educational course materials. Both faculty and students must have web access in order to use it, but access can be from anywhere the Internet is available. Materials that may be included are syllabi, lecture materials, discussions, tests, and homework solutions, among others. Coursework can also be submitted through WebCT. The following are some of the recognized^{2,3} advantages and disadvantages of using WebCT and its various tools.

Course Syllabus. One of the first uses is to make the course syllabus available electronically. Since it remains on the website throughout the course, students can refer to it at any time if they need to recall the information it contains. This typically includes course objectives, grading policies, office hours and other administrative information. It also reduces the number of questions about such issues.

Assignments. All of the assignments (homework, projects, or other types) have a separate tool in WebCT. Students can always refer to this to determine what is due when, and use it to submit their work. The instructor can use it to review the submitted work, including when it was submitted, and to assign an appropriate grade. As with the syllabus, this remains viewable throughout the course, and so reduces the questions that arise about due dates and similar issues.

Course Materials. Lecture notes, supplementary readings, multimedia files, and various other types of materials can be made available via the website. These can be accessible throughout the course, or for selected periods. Students can choose to view or download the materials at their discretion and convenience.

Quizzes. Online quizzes can be readily given with WebCT. Questions can be multiple choice, or short answer, or paragraph, or matching, or require a calculated answer. All of these can be used to create online quizzes and tests. Grading can be done automatically for those question types that permit it.

Grade Book. This tool allows electronic recording of grades on the website. Each individual student can view his/her grades (and only his/her grades). All students can also view how they did in comparison to other students, if the instructor permits this feature. Students can use this feature to monitor their individual progress in the course, which gives them a greater sense of responsibility for their own success.

Bulletin Board. This useful feature permits the easy dissemination of special announcements. Items such as emergency class cancellations, assignment postponements or similar items can be readily distributed. A minor feature but extremely useful when needed.

Chat Rooms. Multiple chat rooms are available for each course. In some rooms, the chat is recorded so that the instructor may review and reply if needed. In others, the chat is not recorded so that participants may speak freely. These rooms allow students to interact with each other and with the instructor without the need of being physically in the same place. Also, the instructor and/or the teaching assistants can have online office hours by using this feature.

WebCT E-Mail. This feature can be used to facilitate e-mail communication about the course. It can be especially valuable in organizing class-related e-mail. Also, students need not have their own, regular e-mail account (although all NJIT students have one).

TurnItIn.com¹⁴ is a commercial website, www.turnitin.com, devoted to the detection and deterrence of plagiarism. Papers submitted electronically via WebCT can in turn be submitted to TurnItIn.com electronically. TurnItIn.com then compares it to its vast database and generates an originality report. Its vast database consists of essentially the entire Internet as well as its own database of papers previously submitted to TurnItIn.com. It has proven to be a very effective deterrent to plagiarism at NJIT.

The website also serves as a proactive tool for students. Using it, they can understand what constitutes plagiarism, both in the traditional sense and in the Internet age. The site provides them with tips on how to avoid plagiarism while still using other work, and guidelines on how to properly cite and reference work by others.

Concerns of Particular Relevance to Graduate Students

International students frequently have several difficult adjustments to make on arrival in the United States for their graduate studies. The educational system is different. In most cases the

language is different. Everyday life is different as American culture is typically quite unlike that in their country of origin. Of course, they also face some of the same problems as the American graduate students. They are no longer the best student in the class. The demands of the course are much more difficult. The nature of the material is often much more theoretical and mathematical. All of these together make the graduate student experience much different from the undergraduate student experience.

Language is the most obvious of these concerns for international students. They are not as confident in their command of the language as their American counterparts. They have more difficulty following traditional lectures. This is especially true if the lecturer is prone to using idiomatic expressions. For the great majority of international students, their reading comprehension in English is better than their listening or speaking ability in English. Their training in English, particularly for those students from China and Korea, has generally emphasized written English as so much of the technical literature is in English. For these students the availability of online course materials, such as lecture notes, makes the course much more accessible. All of the lecture notes in the course were therefore made available on the WebCT course site.

The change in educational system can be quite significant for many students. The traditional way of conducting this type of course was with a weekly lecture, a midterm exam and a final. For some of the graduate students this is a familiar format, for others a new experience. Introduction of the use of WebCT for a significant portion of the course delivery was a novel method for all of the students, and thus had a leveling effect. Differences in educational background also mean that everyone had different versions of the undergraduate material upon which the course relies. At any given university, including NJIT, the natural assumption is that each student's background is similar to what NJIT undergraduates receive. This is not a valid assumption in general, and so availability of supplementary/review material pertinent to the appropriate undergraduate course can be, and should be, made available. This is readily done with WebCT. Students who need it can access this material; others can ignore it if they like.

Regular exams – a midterm and a final – do not allow for differences in student abilities. Not all students work at their best in the time pressure of an examination. Furthermore, these types of exams are typically very problem-oriented. A situation is described, and the student is expected to develop an appropriate mathematical description of it, and then use it to calculate an answer. Such types of questions, and students' answers to them, can provide valuable evidence of how well (or not) a student comprehends the material. But they are not the only legitimate measure. Qualitative questions, conceptual questions, and other nontraditional types of questions can be quite valuable as well. Further, these are readily asked and answered via the WebCT format. Using the quiz feature, a weekly quiz was given via WebCT in which these types of questions were asked. The students were able to take these quizzes at any convenient time for them during the week; the time limit was purposefully set to be quite long for the questions asked. These alternative evaluation methods are quite important and quite helpful to those students who for one reason or another do not perform well on traditional exams. Furthermore, several students have since commented that the quizzes helped them keep on pace in the course and to recognize the significant issues in the material.

The more theoretical nature of most graduate courses, including thermodynamics, also benefits from the nature of the WebCT course delivery system. Students can readily review the lecture notes and supplementary material available on the website. The course chat and e-mail features increase accessibility to assistance, not only from the professor but also from fellow students. This feature is particularly significant to the part-time students who are pursuing their graduate degree while working full-time. They often cannot come to campus to meet either the professor or their fellow students, making these alternative forms of course communication quite valuable. The e-mail was used quite a bit, however, the chat room feature was under-utilized despite the establishment of on-line office hours. This may have been due to some of the issues mentioned earlier, such as language difficulties or disparities in schedules.

An integral part of the course has always been a small “research” project. It normally involves the students doing a critical review and evaluation of a specialized subject related to thermodynamics. An unfortunate observation in the past has been that many of the graduate students tended to be either unaware or unconcerned about the ethics of plagiarism. They have never before been expected to do a critical review of anything published. They are reluctant to express, or even to form, an opinion of their own. If it is published, it must be right! (Of course, we as faculty members know better.) They would all too often rely on another source for their review – thinking they were doing what was requested. The introduction of TurnItIn.com has greatly improved this. It emphasizes the seriousness of the appropriate ethical approach. It also gives the students themselves a tool with which they can evaluate the originality of the work. TurnItIn.com is also much easier to use when the submissions are made electronically, as they are with WebCT.

Results/Observations

The use of the online tools WebCT and TurnItIn.com was fully implemented this past year in the course ChE 611 – Thermodynamics. This is a required course for all graduate students in chemical engineering. This past year, there were fifteen students in the class. Of these, six were international students who were in their first year in the United States, another six were part-time students pursuing their M.S. degree on a part-time basis, and the remaining three were full-time American graduate students.

The course consists of an extensive review of what is covered in most, but not all, undergraduate chemical engineering curricula. The topics for this part of the course include general thermodynamic relations, thermophysical property correlation/estimation and phase and reaction equilibrium. The bulk of the course covers the molecular basis and interpretation of thermodynamics. The material tends to be very abstract and relies upon a good theoretical understanding of the subject.

All of the course materials were available via the WebCT site. This included the lecture notes, supplementary material, examples of old exams, homework solutions and exam solutions. There was a weekly quiz related to the material covered in the previous week’s class. There were two projects in the course, one done individually and one done in groups; the latter also required a presentation. All project materials were submitted via WebCT and evaluated with TurnItIn.com. All material was graded using WebCT.

The average student evaluation for the instructor was not significantly different from previous years (just under 3.5/4.0). However, the average student evaluation of the course was significantly higher (3.4), up from a past average of 3.1. The only other statistical changes from previous years involve two self-assessment questions. Students rate their own preparation for the course (from previous courses) as significantly worse than in past years (2.6 vs. 3.1), and they rate their attendance as significantly better than in past years (3.7 vs. 3.4). These results lead to speculation that the WebCT aspects helped the class be more aware of how well they knew (or didn't know) the course material.

Although the number of students involved is probably too small for the foregoing statistical analysis to be meaningful, the comments on the online aspects of the course were almost universally positive. Some of the comments from the course evaluations were:

“The notes online were a big help getting prepared for class.”

“The weekly quizzes forced me to keep up with the material and to prepare for each class.”

“I'd heard from some friends about copying on last year's project using turnin.com was a good idea.”

“I really liked being able to check up on my grades by computer, also having the solutions posted so I could check my work.”

In conversation, several international students indicated it was easier to follow along in class because of the lecture notes. They also particularly liked having the grades online. Other students commented that online submission of projects was also cheaper as they did not have to buy either paper or folders.

The only negative comments were from one student who had a poor Internet connection at home. That student claimed that the downloads took a long time and that the time limits on the weekly quizzes, even though long, were a problem due to dropped connections.

Recommendations

All of the previous articles and talks that the author could find about using online tools in course delivery focused on undergraduate courses. In many respects, the advantages of this approach are more significant for graduate courses. This is particularly true if any of the following are true:

- The students are international students, as their use helps to reduce language and cultural barriers
- The students are pursuing their degree part-time, as their use greatly improves accessibility for those students
- There are projects or other creative work being submitted, as their use helps to promote ethical behavior and to easily detect incidents of plagiarism

All of the above are much more commonly the case in graduate courses than they are in undergraduate courses. Thus the use of tools such as WebCT and TurnItIn.com are highly recommended for use in graduate courses. The only drawback is that the instructor must learn to

use the tools. The upload/creation of WebCT materials also requires some effort on the part of the instructor. However, the ultimate gains in course management and student satisfaction far outweigh these inconveniences.

References

1. Nicoll, J., and N. Laudato. "Assessing the Impact on Students of Online Materials in University Courses," www.educause.edu/ir/library/html/edu9952/edu9952.htm, accessed January 8, 2004.
2. Rosenkrantz, P.R., "Lessons from Teaching Engineering Economy as a Hybrid On-Line Course Using WebCT", Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, June 2003.
3. Merrill, J.A., M. Lamont and R.J. Freuler, "The Potential & Pitfalls of Online Course Management: Experiences in a Large-Scale Freshman Program", Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition, Montreal, Canada, June 2002.
4. Luttrell, G., "Web-Based Discussion Activities That Enhance Upper-Division Engineering Student Learning", Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, June 2003.
5. Szarolletta, W.K. and K.D. Lutes, "Improving Mechanics Student Satisfaction Through On-Line Data Dissemination and Laboratory Report Submission", Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, June 2003.
6. Goolsby, L.K., "Converting a Traditional Lecture/Lab Programming Course to an Online Course", Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, June 2003.
7. Fidan, I., L.L. Neal and R.J. Clougherty, "Design, Implementation and Assessment of WebCT-based CNC", Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, June 2003.
8. Van Dyk, L., "Engineering the Education Industry to Educate the Industrial Engineer", Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition, Montreal, Canada, June 2002.
9. Pardue, S. and C. Darvennes, "Dynamic and Resonating Use of WebCT", Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition, Montreal, Canada, June 2002.
10. Kortemeyer, G. and W. Bauer, "Multimedia Collaborative Content Creation (mc³): The MSU LectureOnline System", *Journal of Engineering Education*, **88**(4), 421-427 (1999).
11. Latchman, H.A. and S.M. Latchman, "Bringing the Classroom to Students Everywhere", *Journal of Engineering Education*, **89**(4), 429-433 (2000).
12. St. Clair, S. and N.C. Baker, "Faculty Use and Impressions of Courseware Management Tools: A Nationwide Survey", *Journal of Engineering Education*, **92**(2), 123-131 (2003).
13. WebCT Company, www.webct.com, accessed January 8, 2004.
14. TurnItIn.com website, www.turnitin.com, accessed January 8, 2004.

Biographical Information

DANA E. KNOX earned his B.S., M.E. and Ph.D. degrees in chemical engineering from Rensselaer Polytechnic Institute. He joined the chemical engineering faculty at New Jersey Institute of Technology in 1982, and is currently the associate chair of that department. He and his wife Petra make their residence in Edison, NJ.