Experiences in Process Control Web-based Learning

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Abstract

As more and more students gain access to computers, the idea of implementing Internet-based chemical engineering courses becomes more of a reality. With web-based learning comes new opportunities and challenges for both faculty and students. In courses where hands-on learning directly facilitated by an instructor is not required, web-based classes offer students the flexibility to complete coursework while still maintaining full-time employment, or when schedule conflicts between classes occur. The independent learning style challenges students to gain a greater understanding of the course material, as interactions between classmates can be limited. A student gains the ability to complete the course at their own pace, which allows the student to blend the needs of the web-based course with other courses or activities.

The key to web-based learning is communication. The ease of communication between the professors and the students, the ability of students to communicate with each other and the ability of the students to easily find and access the information they require are all vital to a successful web-based learning experience. Successful communication in a web-based course is dependent on the web site interface chosen and on the willingness of both the professors and students to utilize the tools of the web site.

This paper explores these issues from the perspectives of two students who have completed the University of Calgary "Process Dynamics and Control" course via the Internet, and the instructors involved with the course. By investigating the benefits and challenges to web-based learning and offering possible solutions to these challenges, it is shown that web-based learning can become an integral part of any Chemical Engineering program.

I. Introduction

The University of Calgary requires "Process Dynamics and Control" as part of the degree requirements for undergraduate students in Chemical Engineering. The course pioneered the hands-on real-time (time domain) approach to teaching process dynamics and control[1]. Students employ dynamic process simulation using a dynamic process simulator, such as HYSYS or Aspen Dynamics[2] to model chemical process plants and their control systems. The student then creates "disturbances" in the plant, which may involve changes in feed composition, flow, system temperatures and/or pressures. The simulator demonstrates in real-time what the effects of these "disturbances" would be on the plant operation, and allows the student to evaluate the strengths and weaknesses of a given process control scheme.

The course is accompanied by a textbook written by the course instructors entitled "A Real-Time Approach to Process Control"[3]. The text contains ten chapters, each of which focuses on a given aspect of process dynamics and control, whether it be investigating the concepts of process gain, time constants and dead-times, or control schemes for distillation columns, or plant-wide control. Associated with the chapters are eight workshops[4], which are to be completed by the student using a dynamic simulator. Each individual workshop explores the concepts explained in the associated chapter, allowing students to assign meaning to the words.

Due to the electronic nature of the workshops, and the fact that all the information needed to complete the workshops is contained within the textbook, it was considered feasible to offer the course over the Internet. To this end a web-course[5] was created, which provides the remaining details necessary to complete the course independently. The web-course contained extra information necessary to complete the workshops, contact information for the course coordinators and links and references to find additional information for the concepts explored in the textbook.

With the textbook and web-course completed in 2000, the course was then offered to cohorts of sixty students in 2001 and 2002 taking the course in a classical mode and in 2002 two students completed it via distance education. Both of the students studying via distance were on internship work terms, as part of their university programs, and were both working for an Engineering, Procurement and Construction (EPC) firm who had a need for dynamic simulation of the process control systems of proposed plant designs. This paper further details the features of the web-course and an evaluation of the success and shortcomings of the web-based delivery of the course.

II. Web-based Course

The web-based course was created in 2000 and implemented in 2001 and 2002 using the WebCT[6] web-course authoring software. Access to the web-course for students is through their University of Calgary e-mail accounts. WebCT was found to be a very friendly tool to learn and apply. It required only four, three-hour classes and limited prior Internet knowledge to be trained to create a web-course using the software.

Figure 1 shows the home page for this web-course. The focus was on easy navigation. The four major icons represent links to information on communication tools; course content and related materials; help with using the dynamic process simulator; and extension material on topics above and beyond the course (other related topics, courses and research in the field).

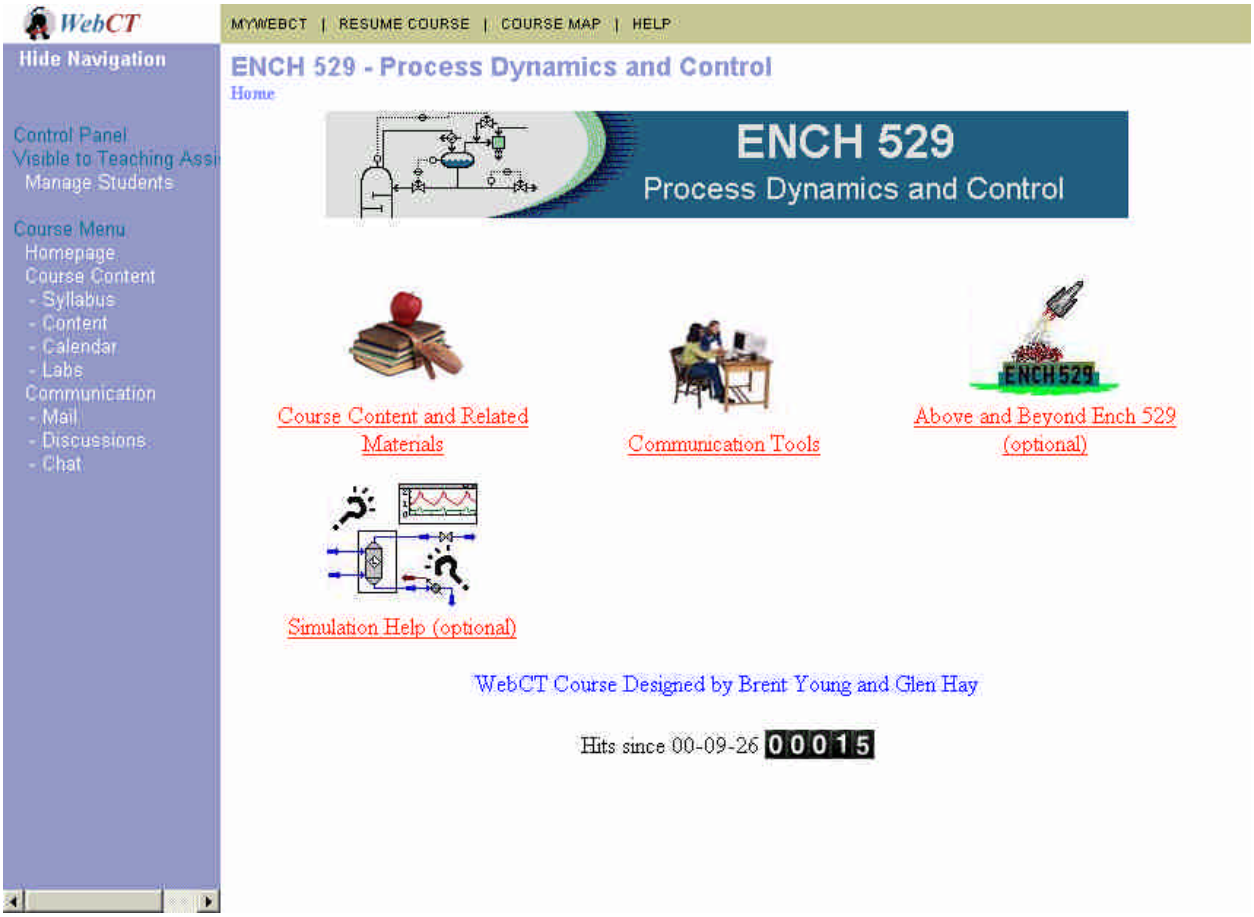

Figure 1. Home page for the web-course.

The "communication tools" link includes "Chat", "Discussion" and "Mail". "Chat" allows for real-time communication and can be used for virtual office hours. "Discussion" involves posted questions and comments and can be private or public. "Mail" allows personal email to students or instructors.

The "course content and related material" link includes the general course outline/syllabus, a calendar with the major deadlines and lecture times that students can also access, laboratory manuals and group assignments as well as the course content itself. The "course content" sub-link consists of lecture power point slides, workshop assignment information, self-quizzes, links to industry web sites and a library images of control equipment/hardware.

The "Simulation help" link is a "frequently-asked-questions" (FAQ) and answers questions about the use of the dynamic process simulator used in the workshop assignments. The idea being that less teaching assistance is required for common problems, and the FAQ can be easily and quickly updated and is always available to the students. This was implemented in 2002 in response to student feedback from 2001.

The "Above and beyond" link includes relevant reading material (extra reading for enlightened students and direction for students who are lost); additional control methods (to show development past course scope and to help students keep pace with technology) and availability of graduate studies course options.

III. Evaluation

Students taking the course were asked to evaluate the proto-type web-course in 2001. These students were taking the course in a classical, non-distance mode. Student use of the web-course amounted to approximately 35%, above and beyond approximately 10% and communication tools approximately 5%. This low usage is a common problem with new web courses and is known as the "field of dreams" mentality[7], i.e. "if we build it, they will come". "We", being the instructors and "they", the students.

Positive comments from the student feedback were as follows:

- Good layout, easy to find information
- Nice to see questions from past exams
- Can start work before the first lecture

Negative comments were as follows:

- Did not know about the web-course!
- Not enough reason to visit frequently
- No visuals given in the self-quizzes
- No marks returned on the web site

In an attempt to address these concerns, the following steps were implemented in 2002:

- A hand out was given on the web-course at the start of the course and a tutorial given on using the web-course.
- A new FAQ section was added to the web-course (the "Simulation help" section).
- The possibility of hyperlinks to visuals was investigated, e.g. for controller tuning tests.
- Marks were returned on-line, which should also motivate the students to visit more frequently.

As a result of these changes students made much greater use of the web-course in 2002. The two students taking the course via distance mode evaluated the best aspect of the web-based course as to the flexibility that it offered them. It enabled them to fit their scholastic activities around their work. By being able to work on the course when they chose, these students were able to produce quality results, both for their EPC employer who had a need for dynamic simulation of the process control systems of proposed plant designs and for the workshop assignments.

Additional feedback from student evaluation identified the following challenges:

- Integration of more visuals into the web-course material e.g. self-quizzes in particular.
- A larger question and workshop database.
- Web-based collection of student assignments.

These challenges are currently being addressed as the web-course is migrating to another software platform, Blackboard[8] as this gives an additional impetus to make further changes and (hopefully) improve the web-course.

IV. Conclusions

Although many students did not use the web-course during their completion of the course, one should not say that the web-based course was unsuccessful. Rather, it is merely in its infancy. The Internet it a great tool for distance education because it allows all students to see what information the instructor wants to provide. Large amounts of information can be made available at one location, which facilitates the learning process. The web-course/site can also be a very effective means of dealing with the hundreds of questions that students have. By creating a detailed and comprehensive FAQ section, the majority of students' questions can be answered on the web-course/site.

The best aspect of the web-based course from the point of view of distance education was the flexibility that it offered the students on internship. It enabled them to fit their scholastic activities around their work. By being able to work on the course when they chose, the students were able to produce quality results, both for their employer and for the workshop assignments. This flexibility will be a highlight for all students, particularly for those taking the course as professional development, or for those students who both work and attend university.

While a web- course is not suitable for all types of courses, such as ones with group work or those that require the use of laboratory equipment, it does offer an exciting alternative to electronic courses. Programming courses, numerical mathematical technique courses, and electronic simulation courses are all highly suited to be taught in a web-based environment. As technology improves and becomes more accessible, the ability to convey courses completely over the Internet becomes a reality.

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