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Abstract

There are some asynchronous web-based courses available in the civil engineering technology field but to the author's knowledge, very few courses exist in structural analysis and design. The advantages of web-based online learning include flexibility and the ability to accommodate various learning styles such as visual and auditory learners, with the visual learning style being the most common among people of college age and older. The Civil Engineering Technology program at RIT recently developed a suite of web-based courses as part of the new Certificate in Structural Design. The online courses available include Structural Analysis, Timber Design, Reinforced Concrete Design, Structural Steel Design, and Applied Mechanics. The web-based course management software used to create the e-learning environment is the Prometheus (or myCourses at RIT) platform developed at the University of Washington. This platform includes an integrated e-mail list, discussion boards, live chat rooms and an online grade book.

The purpose of this paper is to present a simple and effective approach used by the author in teaching a structural analysis distance-learning course. Structural analysis is a very analytical course that involves a lot of problem solving, diagrams and figures; consequently, a combination of web-based and text-based delivery formats was used in this course. The course was divided into several modules with each module having its own Intended Learning Outcomes (ILO's). The course modules serve as a benchmark and compass to guide and measure student learning throughout the quarter. After the completion of each module, the students were asked to provide quantitative feedback on the ILO's for that module to the instructor, thus enabling the instructor to reinforce any concept that may not have been fully grasped by the students. Student-to-instructor interaction was maintained through the use of the discussion board in myCourses and by e-mail. The syllabus, course modules, homework assignments and other pertinent information were posted on the course web site. Weekly homework was assigned and the students submitted their homework to the instructor by fax. A proctor that was pre-approved by the RIT Office of Online Learning proctored all the tests and the final exam in this course in the student's locality. In this paper, the author discusses the organization of the course, the course modules and ILO's, student-to-student and student-to-instructor interactions, feedback and guidance, and students' responses and lessons learned. Based on the student feedback and performance in this course, we conclude that the structural analysis course has been successfully delivered via a combination of web-based and text-based delivery formats.

Introduction

Some web-based courses are available in civil engineering technology but very few online courses exist in structural analysis and design[1, 2,10]; this is because the Internet environment is not very conducive to comprehensive design and analytical problems[5] .

Strenth presented a web-based course in Civil Construction using the Web-CT platform[10], and Carter presented information on two asynchronous web-based courses in electrical engineering technology using Web-CT and Centra.[2] In these courses, PowerPoint slides of the lectures – that are voiced over – were also provided in a CD-ROM format to reduce bandwidth requirements. He reports that an extensive amount of time was required to prepare the thousands of slides needed for the course.

The author presents a simple and effective approach that was used recently to teach a structural analysis course in an asynchronous web-based distance-learning format. The objective was to model the classroom environment as closely and as economically as possible, while adhering to the seven principles of effective teaching[4] . A typical on-campus lecture process involves the instructor standing before the class, writing instrument in hand and a board to write on, and a voice to narrate the concept being taught.[2] The process of digitizing what is written on the blackboard and recording what is spoken is a very time consuming and arduous process[2].This is even more so if the lecture needs to be modified periodically. Carter reports that each of his web-based courses requires no less than 10,000 PowerPoint slides, and 5 to 10 hours to prepare materials for a one-hour web-based lecture.[2] Brobers and Lin also report that a 50-minute lecture file with audio and video could be larger than 200 Megabytes.[1] This is obviously not very cost effective when compared to a typical on-campus course.

According to Felder and Silverman, "most people of college age and older are visual learners and presentations that use both visual and auditory modalities reinforce learning for all students."[3] To cut down on the lecture preparation time, the author decided to adopt a simple course delivery approach that focused mainly on the visual learning style; the auditory learning style was not addressed in this course. No streaming video or PowerPoint slides were used. Instead, a combination of web-based and text-based delivery formats was adopted and the course management software, myCourses, was used. This platform includes an integrated e-mail list, discussion board, live chat rooms and online grade book. The course was divided into several modules, each having its intended learning outcomes (ILO's). These modules and the ILO's serve as a baseline with which the student can measure their understanding and comprehension of the course materials. At the completion of each module, the students are required to provide a quantitative assessment of the ILO's, thus enabling the instructor to reinforce any concept that may not have been fully grasped by the students, and to make any necessary midcourse correction.

Organization of the course

As part of the newly developed 20-credit certificate in structural design, several of our existing structural courses in the RIT Civil Engineering Technology baccalaureate program were developed for the online environment. These courses include Timber design, Structural Analysis, Structural Steel Design, Reinforced Concrete Design, and Applied Mechanics of Materials.

The Structural Analysis course is a 4-credit undergraduate level class. Five students were registered for this class and their locations varied from the west coast to the east coast. The main text used in the course consists of course notes specifically developed by the author for the online format; this is supplemented with a published textbook on structural analysis. Pre-approved proctors in the student's locality supervise the tests and final exam; proctors might be the local librarian or the student's boss at work.

Our objective in this online course was to model the on-campus classroom experience as closely as possible. The web-based Prometheus (or myCourses) platform was used as the interface or medium for this course. As shown in Figure 1, the myCourses platform is divided into several sections namely: Syllabus, Grade Book, Messages, Files, Discussions, and Utilities.

The SYLLABUS section is the first screen seen by the students after they log on to the course website in myCourses; this section shows general course information, instructor information, and course description. A short biography, general introduction to the course, and links to the course syllabus and course modules are posted in the Course Description section of myCourses. The course is organized into six modules each with its intended learning outcomes (ILO's). The modules encourages active student learning and motivates the student to take responsibility for learning the course material and to achieve the stated intended learning outcomes. A take-home refresher pre-test in statics is assigned to the students before the start of the quarter, and they are required to post their answers on the discussion board. None of the students resisted posting their pre-test answers on the discussion board, and the pre-test was not a graded part of the course. The author uses the students' performance in the pre-test to gauge their level of understanding of the prerequisite courses, and to identify the students who are in need of extra help.

The Discussion Board section of myCourses, as shown in Figure 2 is used to set up electronic discussion forums on several topics including Statics Refresher Exercise, Tests, and Homework questions.
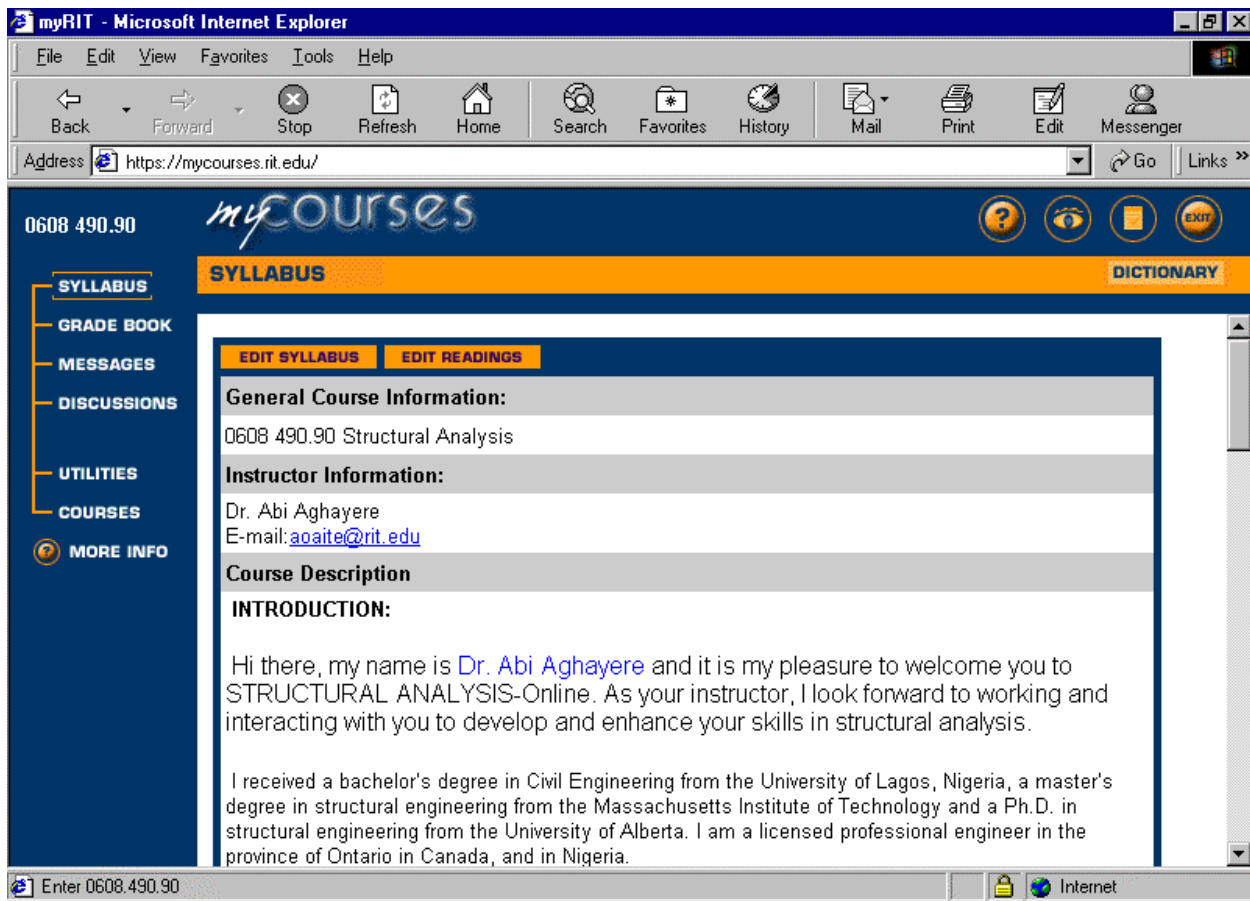
Figure 1

Intended learning outcomes

Each course module had a set of intended learning outcomes (ILO's). The ILO's give the students a means of assessing how well they understood the topics they read. The stated outcomes also served as a goal for the students thus promoting good time management and high academic performance. The feedback collected by the author at the completion of each module guides the author in continuously improving the delivery of the course so that the students will immediately benefit from their feedback. A sample course module showing the quantitative feedback on a scale of 1 to 10 beside each topic is shown in Appendix 1. A set of course notes, written in a concise and practice-oriented format with many practical examples that actively engage the students was developed for this course by the author. Though a published structural analysis textbook was specified for this course, the students seem to prefer the author's course notes as demonstrated by the comments in the course evaluations. The course notes help the students achieve the intended learning outcomes.
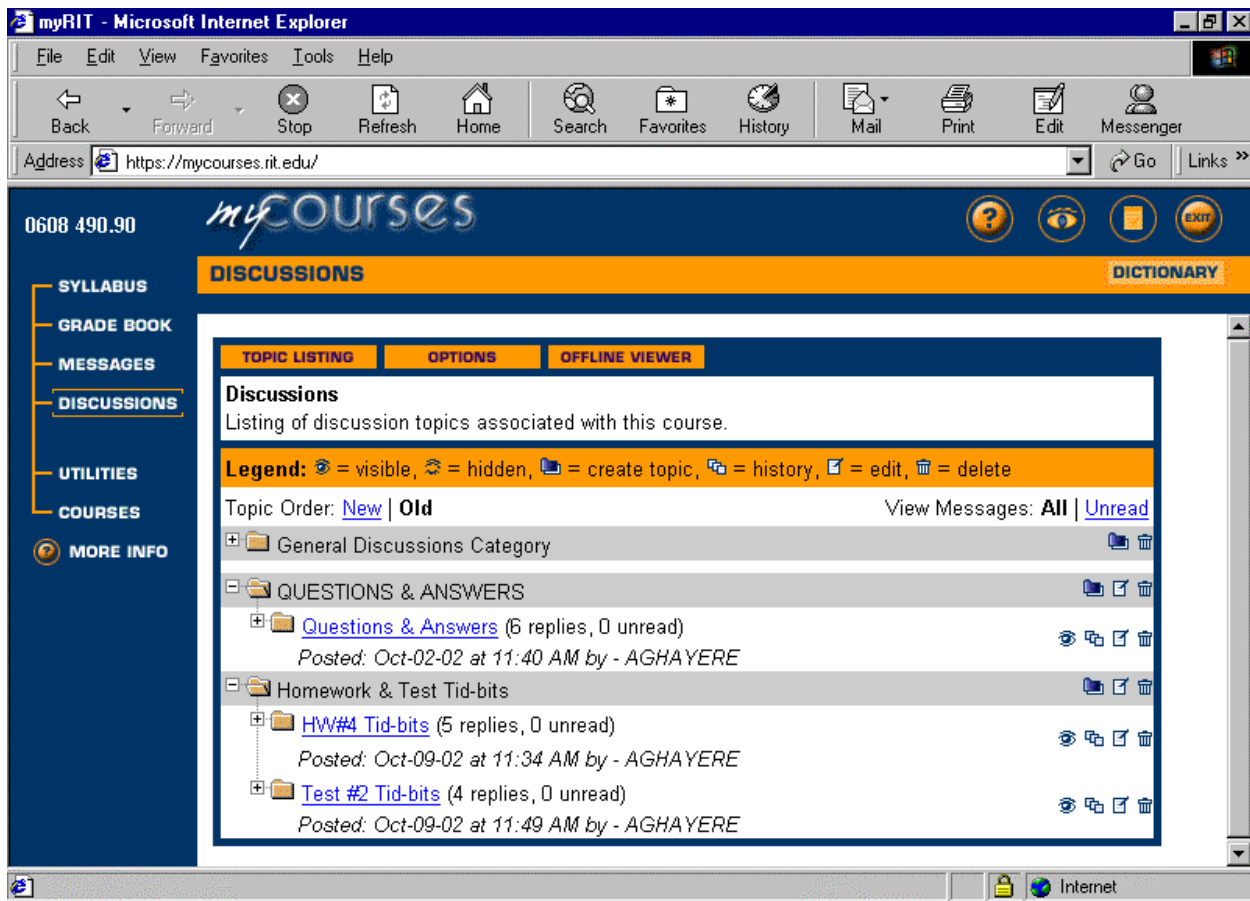
Figure 2

Interactions and communications

Student-to-instructor, student-to-student, and student-to-course content interactions were facilitated in this web-based course by making participation in the Discussion Forums a graded part of the course. Instructor expectations for the discussion forum are posted in the course description area in the Syllabus section of MyCourses. Students were required to use the Discussion Forums to ask questions so that all students in the class will benefit from the posted questions and answers. They were also encouraged to post answers to questions and not to rely solely on the instructor for answers. The author kept track of the discussions constantly and chimed in on the discussions from time to time to keep the students focused. The author restricted the use of e-mail from students only for questions of a personal nature. Whenever questions of a non-personal nature were sent to me by e-mail, I usually responded to the whole class so that all the students could benefit from my response. I also contacted some students by phone whenever attempts to contact them by e-mail were unsuccessful. Though deadlines for the course were clearly stated in the course syllabus, I was responsive to infrequent requests from students for special dispensation regarding tests or homework deadlines that conflicted with their

work schedule, considering the fact that many of these students are balancing and juggling family life, work and school at the same time. However, these types of requests were very few and far between. MyCourses has the ability to measure how often each student accessed the course documents. This gives the instructor a tool to monitor student involvement in the course and to contact students that may be falling behind and therefore improve retention and academic performance.

Feedback and guidance

Since there is no face-to-face interaction between the student and the instructor, it is important that students receive regular and consistent feedback from the instructor, and clear guidelines for interaction with students should be provided.[4] The author's timeline for responding to messages is clearly stated in the course syllabus; my practice is to respond to messages and postings on the discussion forum within twenty-four hours (forty eight hours on weekends) and to return all graded work within seven days.

Students submit their homework assignments by fax to the instructor and the graded homework assignments are returned by fax to the students. Feedback on the homework assignments was provided by extensive written comments on the assignments, and by e-mail, or postings on the Tests/Homework Discussion Forum. Whenever students encountered problems with the homework assignments, they were encouraged to fax their work to me for review; the marked-up work was subsequently returned to the student with comments indicating their mistakes or errors. This way, online distance-learning students receive somewhat similar "office-hour" guidance that on-campus students receive.

Test tid-bits were posted on the Discussion Board before every test to give the students some guidance on what to expect in the tests and exams. A proctor of the student's choice but pre-approved by the RIT Online Learning Office (RIT-OLO) supervises the tests and final exam in this course. The exams were mailed to the proctor by the Online Learning office with all the necessary exam instructions; the proctor returns a copy of the completed exam by fax to the RIT-OLO on the day of the test and sends back the original copy by mail.

Students' response

The objective of every course, whether online or on-campus should be student learning. To assess the effectiveness of the combined web-based and text-based course delivery format, the students completed an anonymous web-based course evaluation. Based on the student feedback, it appears that the delivery model adopted was very successful. Some of the unsolicited comments from the students are as follows:
"I would like to say that the course structure was very effective";
"Your course notes were a great help and you seemed to provide your tid-bits just at the right time."

A tabulation of the web-based course evaluation was very positive and similar to the instructor's evaluations for a similar on-campus course that was taught concurrently. Samples of the students' comments from the course evaluation are as follows:

"[The instructor] was very prompt in answering questions and used course notes that helped greatly with [the] online course"
"I'm not a CE major; however, I really enjoyed this course and look forward to Structural Design"
"Consider having [the text provided by the instructor] as an item in the bookstore"
"I was completely satisfied with the online components [of this course]"

Conclusions

The author has presented a simple and effective course delivery format used in teaching an asynchronous online structural analysis course for distance learning students. Distance learning courses require a lot of self-discipline and motivation on the part of the students in order to succeed. To develop critical thinking and communication skills in the students and to overcome any feeling of isolation, the students were required to participate in the discussion forums, and this was a graded part of the course. Web-based learning requires prompt feedback on homework assignments, tests and questions. It requires more preparatory work, more writing, and more instructor-to-student communications on the part of the instructor than would be the case in a comparable on-campus class; this is because of the any place-any time nature of asynchronous online courses. For an analytical and very technical course like structural analysis, which involves a lot of equations and graphics, the writing demands on the instructor are even greater. However, as a result of these writing demands, more thought is usually given to the response to questions in a web-based class than in a typical on-campus class. The writing demands on the students help to enhance their written communication skills. Students are also more apt to ask questions in writing than in a face-to-face class.

Based on the students' comments, the structural analysis course notes developed for this online course has been proven to be very successful in aiding student learning of the course material. In summary, the selected student comments are a testimonial to the efficacy of the course delivery format adopted for this asynchronous web-based structural analysis course. In the author's experience, teaching this online course with the delivery method described herein was not so much more demanding on the author's time than a comparable on-campus course. This is in contrast to the conclusion drawn by Carter, who concludes that the workload attributed to a web-based course is twice that of a comparable on-campus course, thus concluding that a workload release is needed by faculty teaching online courses.[2]
In the author's opinion, for web-based distance learning courses in civil engineering technology to be economically viable, course delivery models must be developed that would require no more resources on the part of the faculty than comparable on-campus courses. Such a course delivery model has been presented in this paper.

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APPENDIX 1

A typical course module with its intended learning outcomes is shown below. The ILO's were assessed by the students on a scale of 1 to 10 at the completion of each module. Through this assessment, the instructor was able to gauge the level of student understanding and make any necessary mid-course corrections.

0608-490-90– Module 1

Reading Assignment:

- Syllabus & Introduction
- Review of Statics
- Course Notes (text # 1) chapters 1 & 2
- Chapters 1 & 2 of text #2

Search on the Web for information regarding the Hyatt Regency Hotel collapse in 1981. Explain how a lack of adequate analysis may have exacerbated the collapse. Submit AS PART OF HOME WORK ASSIGNMENT #2 a detailed report (3 page minimum) illustrated with sketches and free body diagrams.

Intended Learning Outcomes (ILO's):

After completing this module, you should be able to:

- Understand the function and purpose of a structure.   9
- Identify the different types of structures and structural elements   9
- Identify the process involved in the creation of a typical civil engineering structure   6
- Identify and calculate the different types of loads acting on a structure or structural element. e.g.

    Dead loads 10
    Live loads 10
      Wind Loads   9
- Calculate applicable live load reduction and reduced live load on a structural element   9
- Differentiate between concentrated loads and uniformly distributed loads.   10
- Work through the examples in Text #1 and complete the first question in homework #1   9
- Calculate the tributary width and tributary area for beams, girders and columns.   9
- Understand the concept of load path (i.e. how a load is safely transferred from the point of application in a structure to the ground) and perform a load path analysis. 6
- Identify the different types of *structural support* and the number of unknown forces in these supports. 9
- Differentiate between the different types of connections between *structural members*   9
- Model a structure using centerline representation, and dimension the model. 9
- Identify one-way load and two-way load support systems, and carry out the modeling of structures for these types of load systems 9
- Understand and state the equations of equilibrium, and draw free body diagrams (FBD) by "cutting" and isolating portions of a structure   9
- Identify statically determinate, statically indeterminate, stable and unstable beams and frames as well as the degree of indeterminacy of a structure. 9
- Work through examples in text #1 and text #2   9
- Complete homework assignment #1   9