Teaching an Engineering Course Online Using Blackboard

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Abstract

Online-based course delivery has become an attractive option for expanding its reach to new students and to added flexibility and convenience of existing students. Since the academic semester of spring '03, the students at the University of New Haven (UNH) have had the opportunity to enroll in such a course. It is the first course to be offered completely online by the School of Engineering at the University of New Haven.

This paper presents and addresses many of the technical challenges that are encountered during the process of developing and implementing an engineering course for online delivery at the University of New Haven. This paper presents the procedure that was followed in transforming a traditional course in Introduction to Engineering for delivery as a completely interactive online course. The results show that there was no statistical difference in student learning between on-campus and online students.

1. Introduction

The key to successful online and traditional classrooms is to analyze course material, determine how well existing material will translate online, create new approaches to communicate with students, and evaluate and rebuild the course as problems arise. The students at the University of New Haven (UNH) have had the opportunity to enroll in an online engineering course since spring '03. The study that compares the on campus with online students shows no significant difference in the learning of students as shown through regular test and other course requirements[1]. In all, students favored the flexibility and convenience of the online course. They appreciated being well informed by the instructor of the expectations, objectives and concepts of the course, and the overall organized nature of the course.

2. Course Description

ES 107, *Introduction to Engineering*, is a three semester-hour course. It provides an introduction to engineering through a realistic and hands-on problem-solving experience. It focuses on engineering design process--the application of math, science, and technology to create devices and systems that meet human needs. It provides an introduction to group work, to oral and written communications and to engineering ethics. The course is required for all freshman-engineering students, and a large number of non-engineering majors at the University of New Haven take it as a scientific methodology elective. Consequently, an estimated 200 undergraduate students annually take the course in sections containing approximately 25 students. There is a relatively even mixture of sophomore, junior and senior students that enroll in the class. The pre-requisite is college algebra.

The online version of Introduction to Engineering is designed to accommodate many students on co-op assignments across the New England area. It also affords convenience for student with unusual schedules and for students who do not live close to campus. In addition, a distance-based format provides local full-time and non-traditional students with an opportunity to enroll and participate in courses with added time flexibility.

Course Outcomes**:** Students should be able to

1. describe the various branches of engineering (civil, computer, electrical, industrial, mechanical, and chemical engineering);
2. apply engineering problem solving techniques; and be introduced to some computer applications used in engineering;
3. understand how to work efficiently as part of a team;
4. demonstrate an understanding of the "Design Process";
5. enhance written and oral communication skills
6. know engineering ethics.

3. Online Development Software – Blackboard

The Blackboard system provides an easy-to-learn online site for communicating with students via email, discussion boards, and announcements as shown in Figure1. Blackboard is a web based educational software platform used by more than 2800 institutions in over 50 countries[2]. Examples of Blackboard usage at other institutions have been documented. [2,3,4,5,6,7]

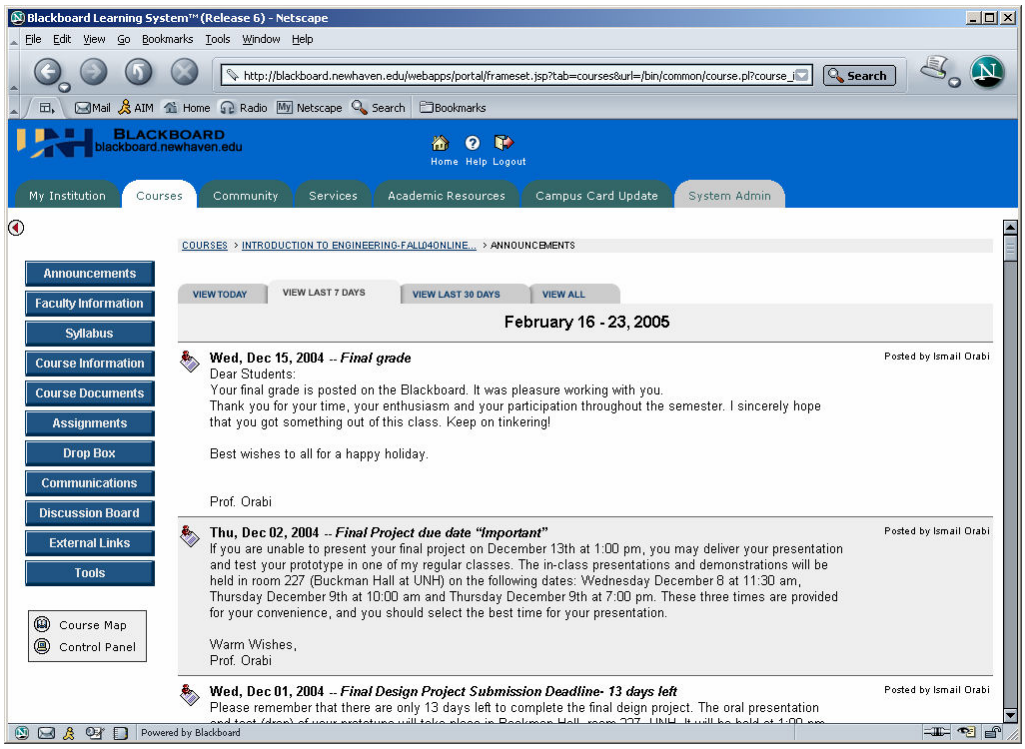


Figure 1: Announcement Page with Links to Other Menus.

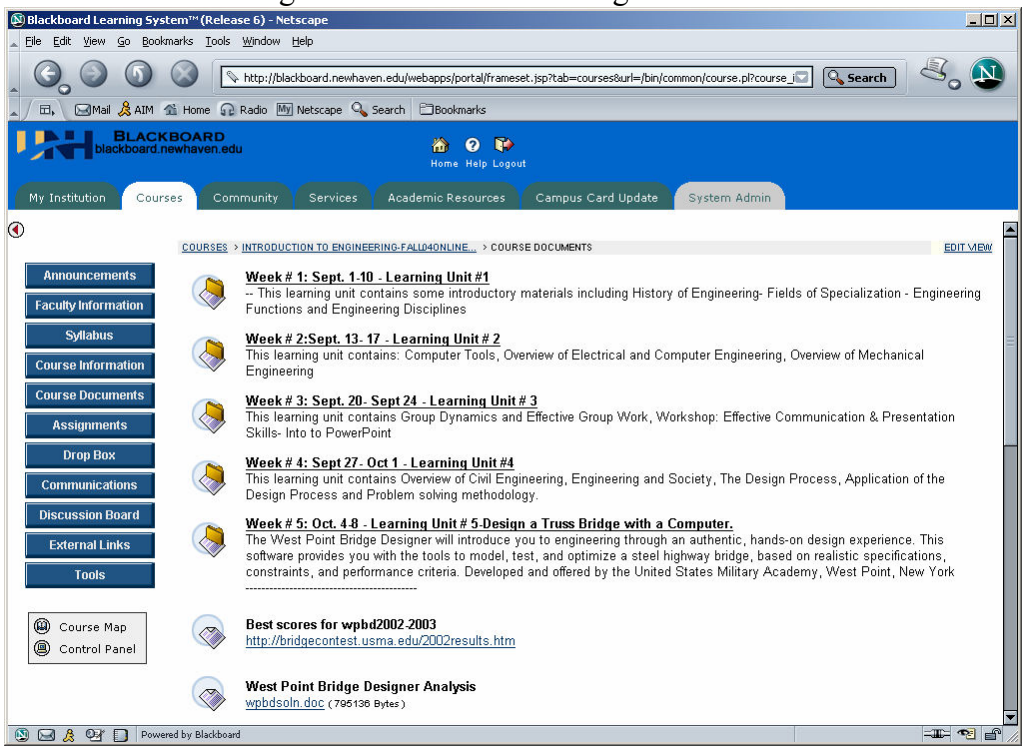


Figure 2: Course Documents Page with Links to Other Menus.

Class documents and assignments can be easily posted for student access 24 hours a day, 7 days a week as shown in Figures 2 and 3. A separate area for students allows the instructor to create forums with a separate discussion board as shown in Figures (4a-4b).
In Blackboard, the Discussion Board tool has allowed the instructor to set up an area where students and instructors can post and respond to messages. As an example Discussion Board Forums are shown in Figure 4a. Students have used the *Discussion Board* to post their replies and comments for each other or for the instructor Figure 4b. The instructor has posted a discussion topic each week and each student has been required to participate in the discussion at least once per week. These responses have been posted in Blackboard and can be seen by the entire class at any time. The quality of participation, questions, comments, and discussion are monitored and guided by the instructor.

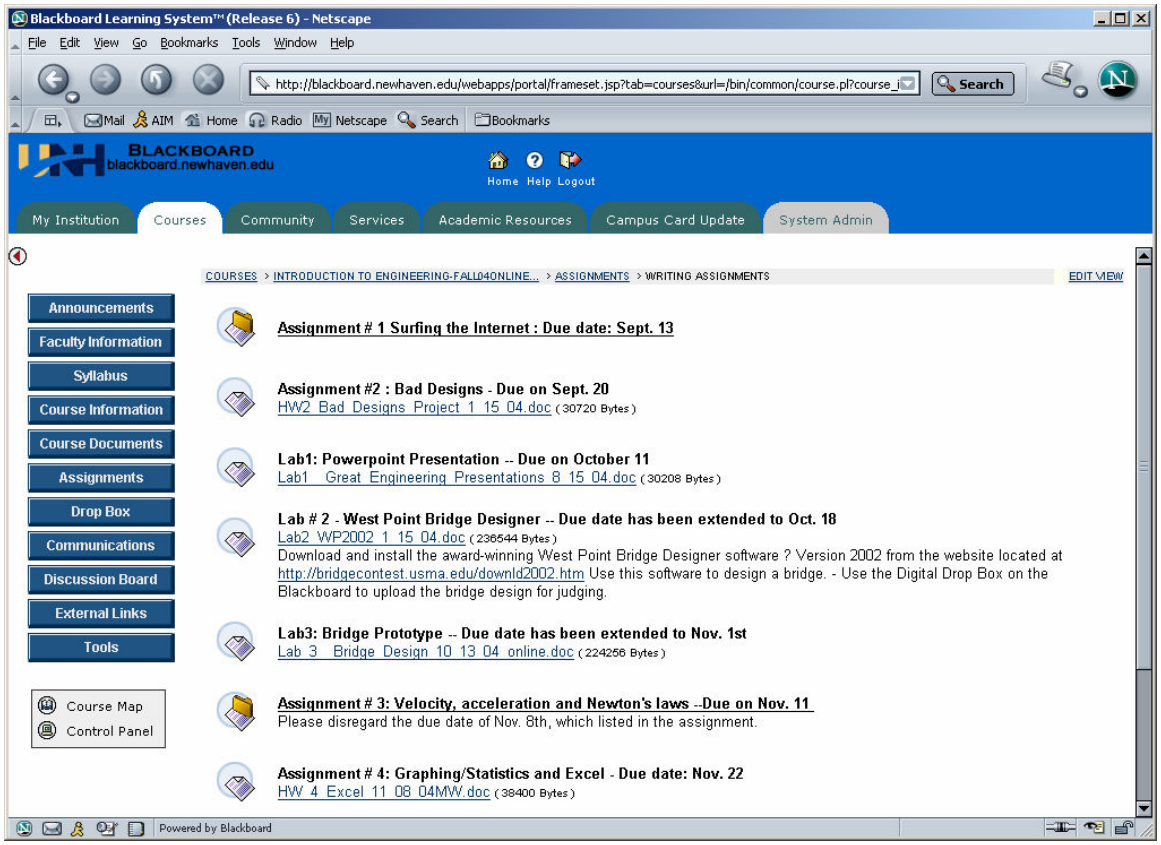


Figure 3: Assignments Page with Links to Other Menus

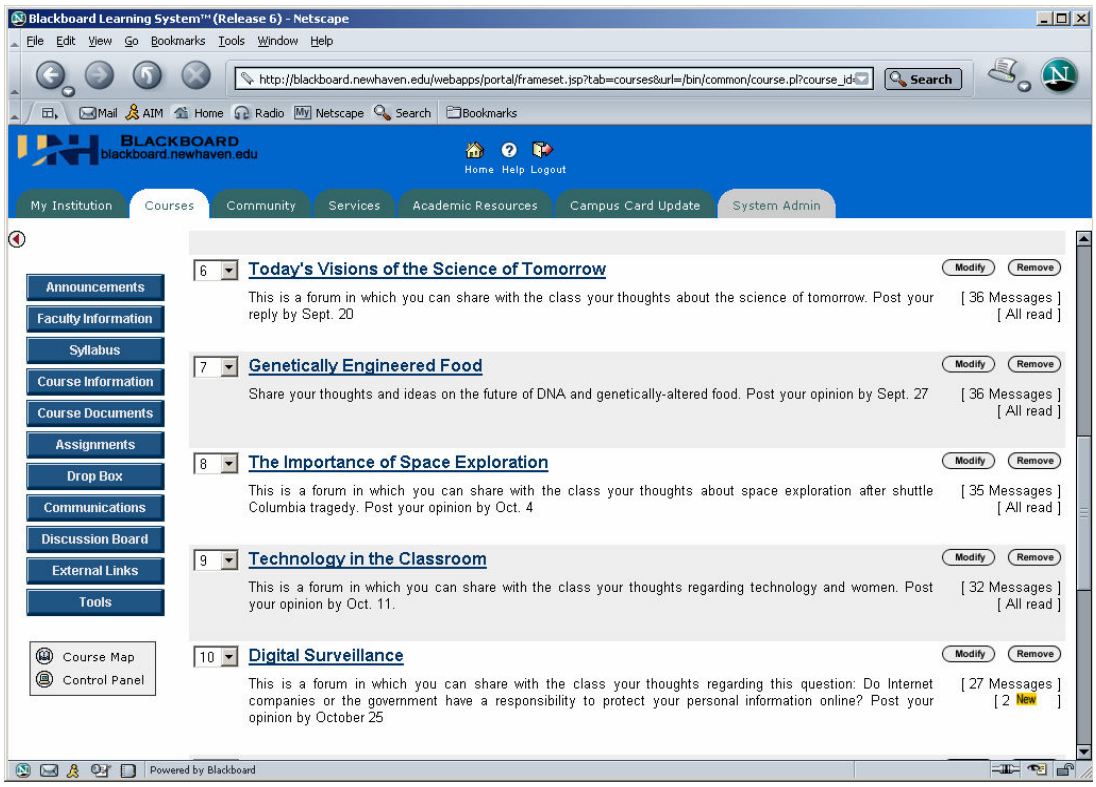


Figure 4a: Discussion Board Forums

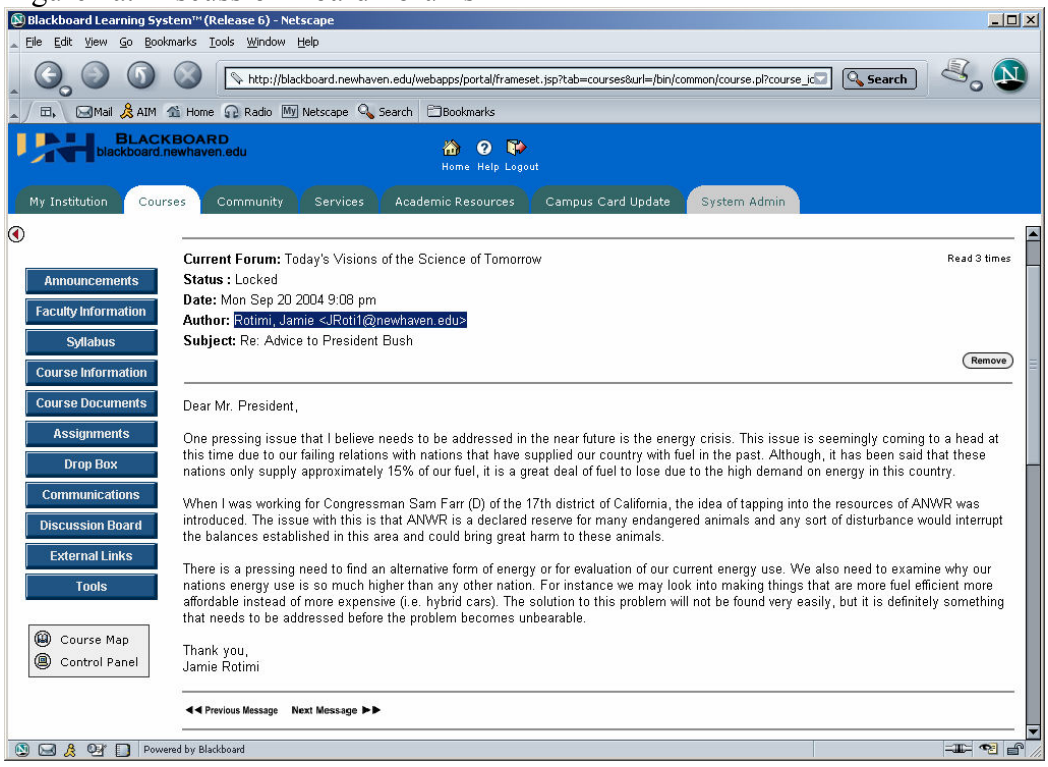


Figure 4b: Discussion Board thread with Links to Other Menus.

4. Course Format Description

The course lecture notes are provided, assignments are given and collected, and quizzes are conducted all on a regular schedule via Blackboard. The tests are available for four hours on the test dates for the online course. Quizzes have a time limit that is designed to be sufficiently restrictive to prevent the students' answering questions by spending a lot of time looking up the material in the text. Students are only allowed one attempt for a quiz and have to complete it within the specified time limit.

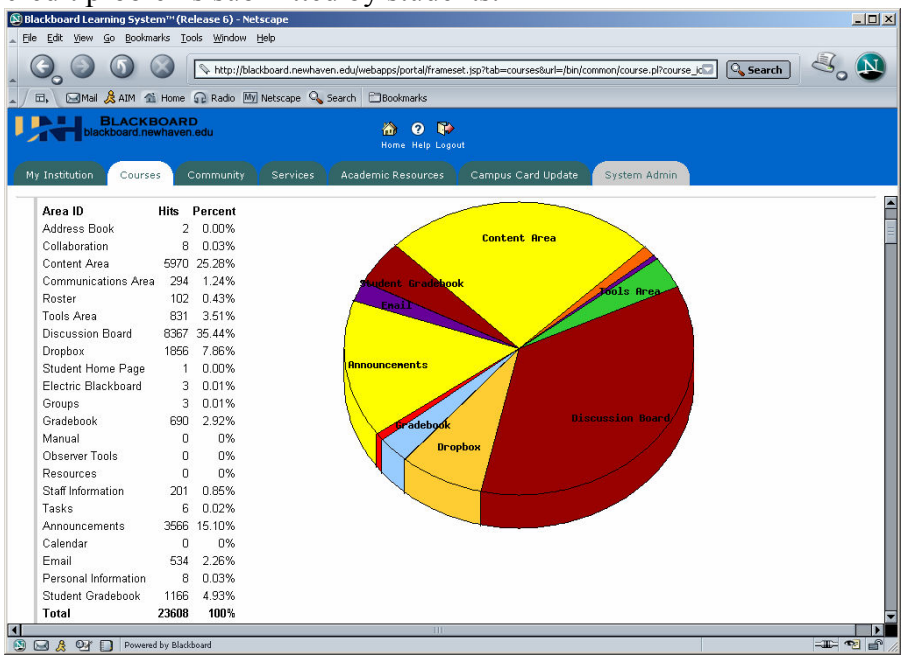
The course format is as follows[1]:

- The online-based course is offered almost exclusively on the web. The class meets once at the end of the semester to present the final design projects. An optional brief meeting at the beginning of the semester is also held to go over the Blackboard tutorial and course syllabus similar to the ones in the traditional format, as well as for testing purposes. Course materials in the form of lecture notes, text-based supplementary materials, discussion groups, and testing are offered through the Internet. Blackboard is used as the course delivery platform.
- The online-based course is composed of twelve learning units. After each learning unit is completed, a timed homework is assigned and submitted online, and graded by the instructor. Three tests are administered online during the semester and graded electronically. Grades are posted on the Blackboard grade book.
- A threaded discussion is given weekly during the semester. The forums present issues regarding current events in technology and engineering. Students are given deadlines to post their opinions regarding the issue.
- Each student is required to write three to five paragraphs about the issue at hand. In addition, each student is required to respond to at least one post from another student in the class. The quality of participation, comments and suggestions are graded and posted in the Blackboard grade book.

5. Course Statistics Access / Application

The "Course Statistics" tool in the Control Panel is a useful tool to find out which parts of the course are being utilized. There are several options available. For instance, you could use Blackboard Course Statistics to generate reports and obtain a summary of the course usage and utilization of the main areas (content, communication, groups, and student tools)[8]. For more specific reporting, you can also use the tracking tool to identify if each student opened the handouts, PowerPoint files, and other documents you made available in the course site. In order to use the tracking tool, you have to select it when you upload each file. This allows Blackboard to track the file during the semester.

A report can be generated to view the overall course statistics (Figure 5), number of accesses over time (Figure 6), user accesses by hour of the day (Figure 7), and user accesses by day of the week (Figure 8). The Digital Drop Box (Figure 9) was used to grade assignments and extra-credit problems submitted by students.



Area ID	Hits	Percent
Address Book	2	0.00%
Collaboration	8	0.03%
Content Area	5970	25.28%
Communications Area	294	1.24%
Roster	102	0.43%
Tools Area	831	3.51%
Discussion Board	8367	35.44%
Dropbox	1856	7.86%
Student Home Page	1	0.00%
Electric Blackboard	3	0.01%
Groups	3	0.01%
Gradebook	690	2.92%
Manual	0	0%
Observer Tools	0	0%
Resources	0	0%
Staff Information	201	0.85%
Tasks	6	0.02%
Announcements	3566	15.10%
Calendar	0	0%
Email	534	2.26%
Personal Information	8	0.03%
Student Gradebook	1166	4.93%
Total	**23608**	**100%**

Figure 5: Overall Course Statistics for the online version of Introduction to Engineering

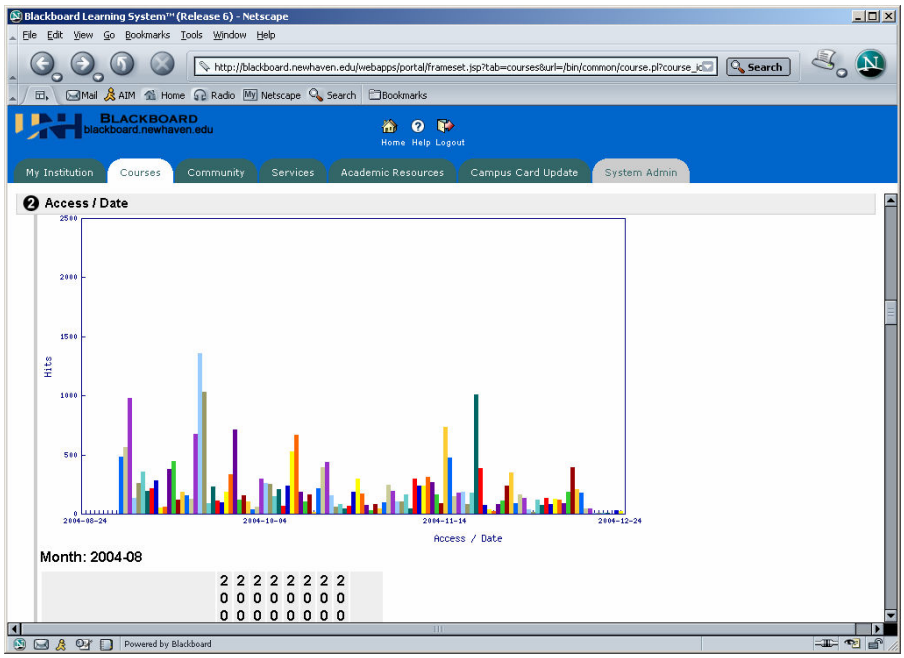


Figure 6: Number of Accesses over Time – from September to December 2004.

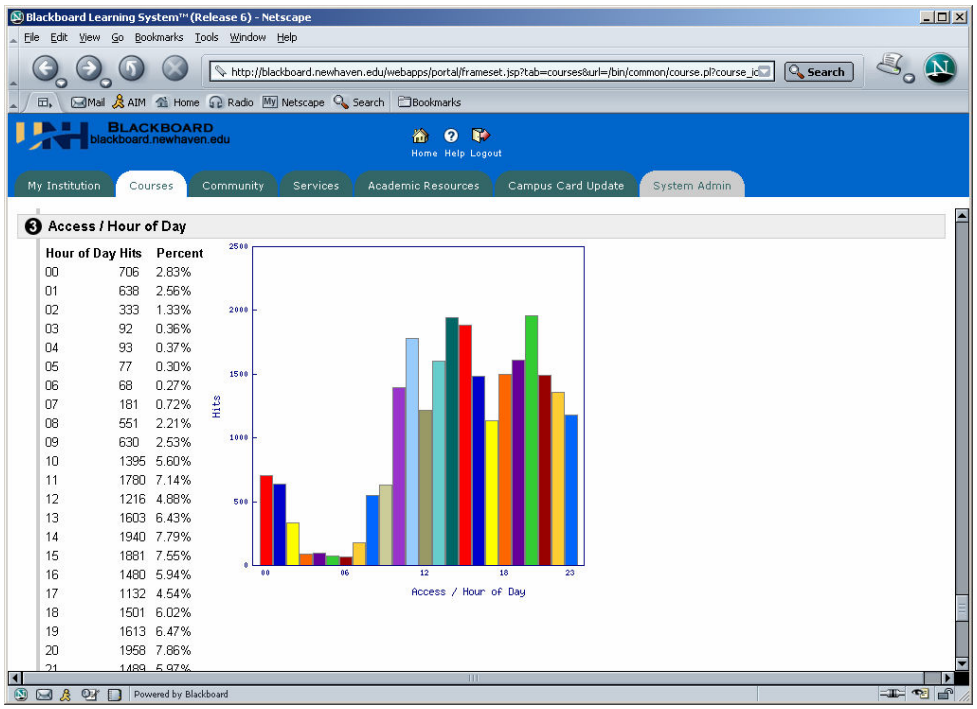


Figure 7: Number of Accesses over Hours of Day

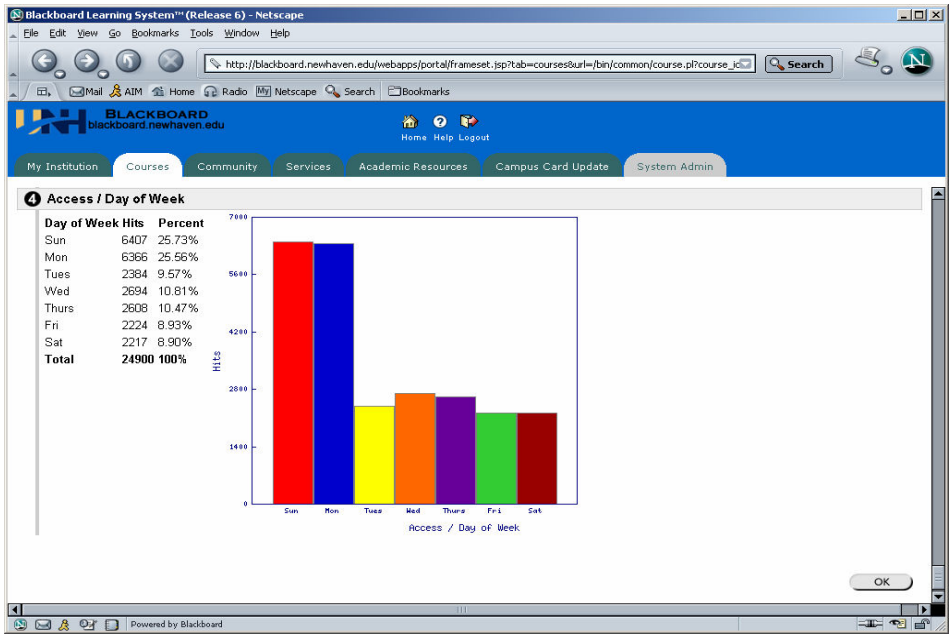


Figure 8. Number of Accesses over Day of Week

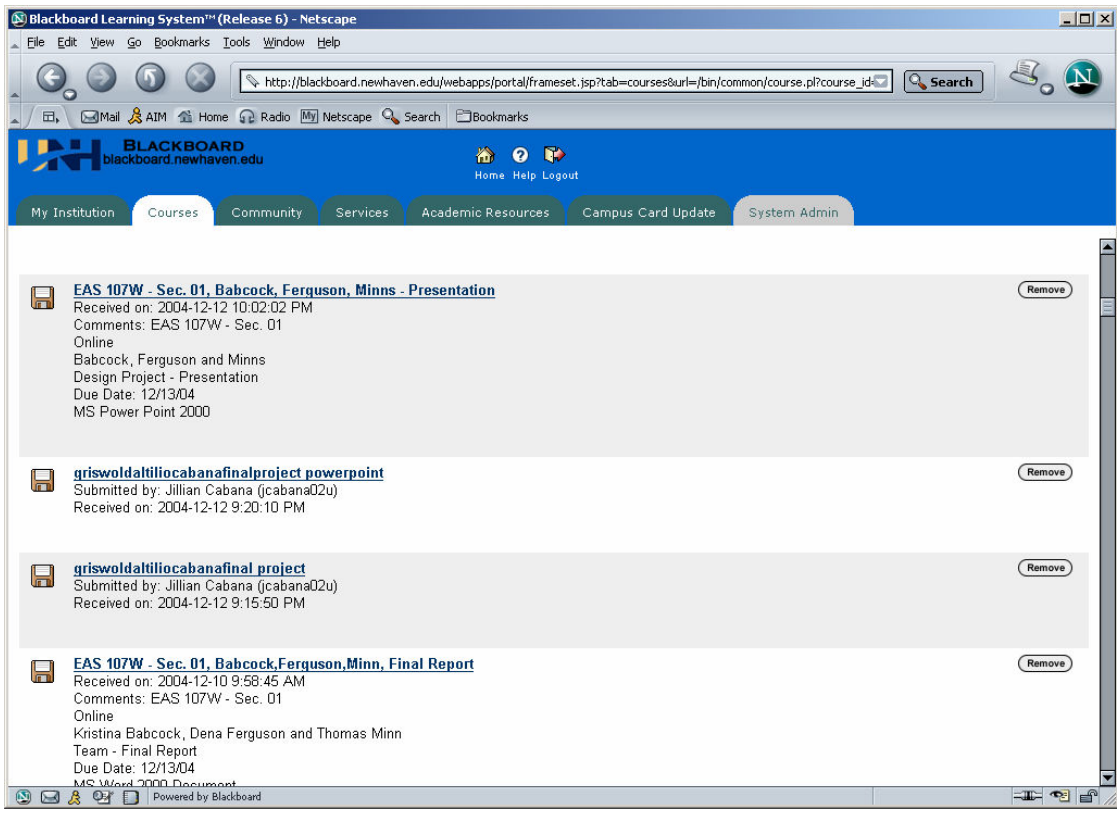


Figure 9: Student Files in the Digital Drop Box.

7. Instructional Materials

Computer-based instructional tools are used in both modes of teaching. It is challenging to use these tools in a way that would be interesting for the students and enhance their learning skills. The main delivery tools are PowerPoint, MS words and Excel. Animation and simulation software are also used in both sections. Excel's built in function is used to help students to build confidence in their understanding of the relevant topics.
Consider for example the fundamental concept of stress analysis of a cantilever beam. The task for this exercise is to develop a spreadsheet that will tabulate the maximum fiber stress at any point along the beam. The user should have the ability to change the following variables: (F, L, t, w). When any change is made, the graphs should automatically update. An example of a spreadsheet is provided below in Figure 10.

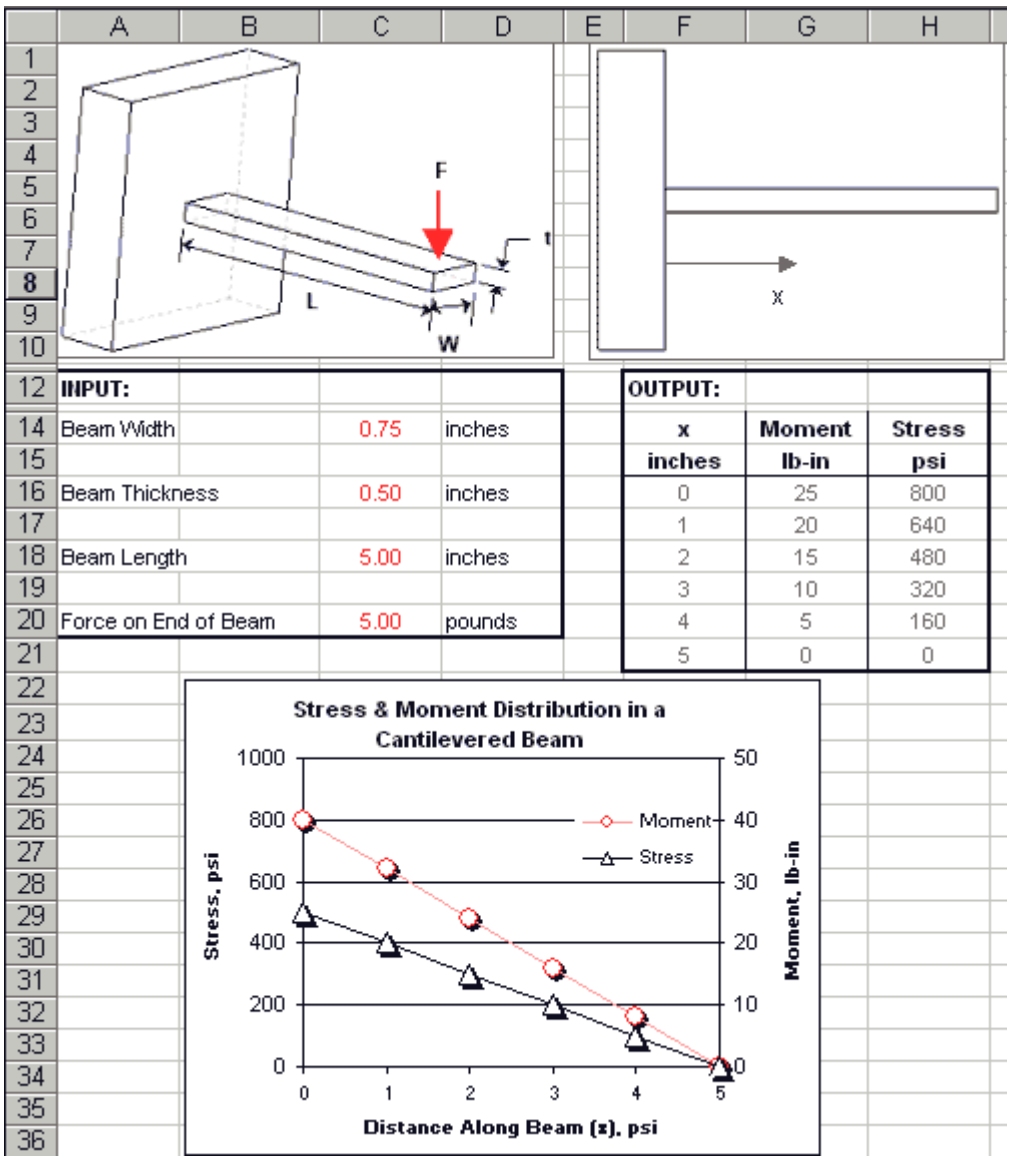


Figure 10: Stress & Moment Distribution in a Cantilevered Beam

6. Sample online Test Questions:

Figure 11 shows the sample test questions. The questions focus on problem solving skills. Students record their answers for each question. Figure 12 shows the results of assessment after the student submits their test. An X or check indicates whether the question is incorrect or correct, respectively. The number of points received for each question is displayed beside the question number.

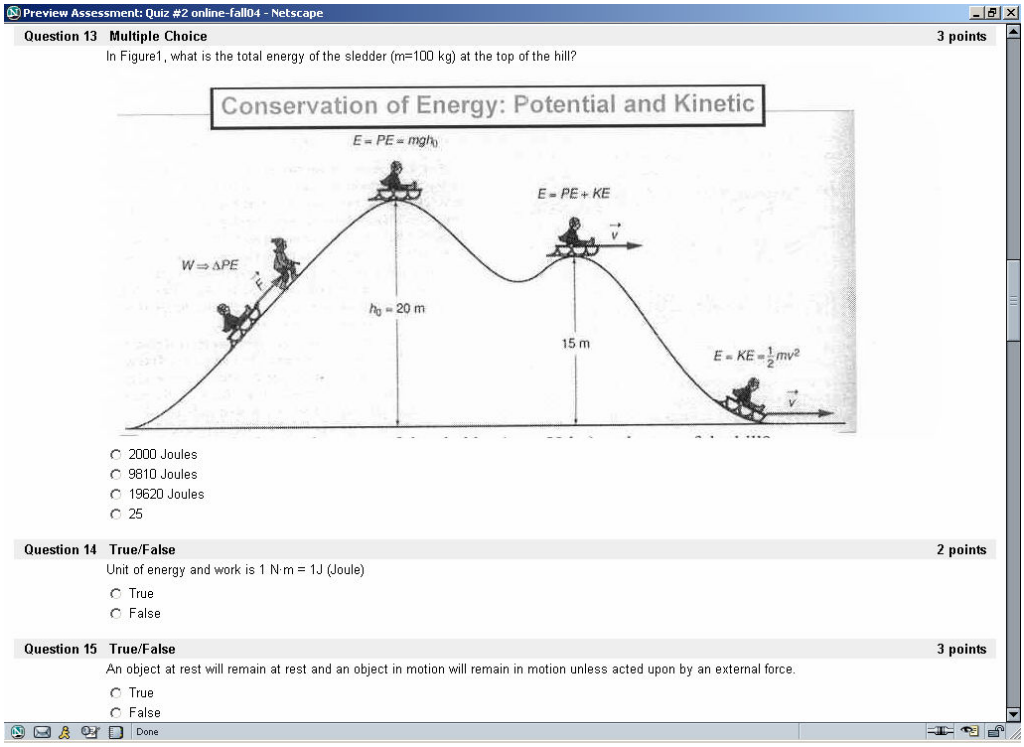


Figure 11: Sample online Questions

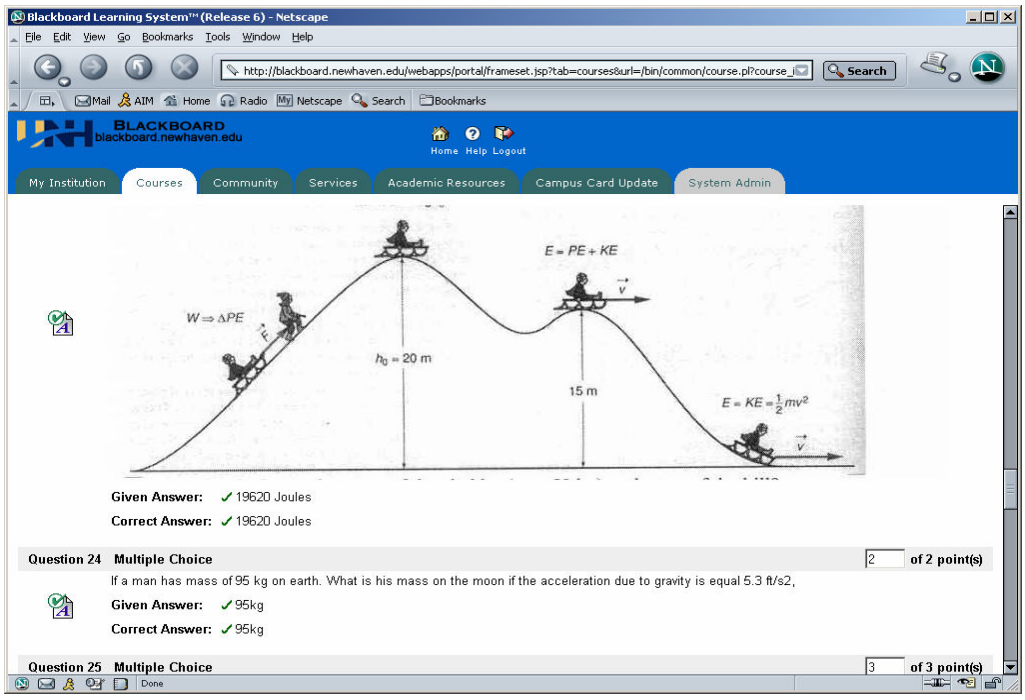


Figure 12: Sample online Questions Results

8. Discussion:

It is an interesting and rewarding experience to develop and teach this online course. The course is offered simultaneously with an on-campus section that is also taught by the same instructor. This allows the direct comparison of the performance of students in the two modes of teaching. The students in the two classes are comparable since they are all drawn from the same pool of students who are already enrolled in our regular programs. The tests and assignments are almost identical in both sections taught by the same instructor with minor variations in the questions.

It is observed that online students have a higher drop out rate (12%) than traditional students (5%). This is consistent with other observations that attrition rates tend to be higher with online courses. However, tests and assignments show no significant difference in the learning of students. The results are much more consistent between the two sections. Figure 13 shows the performance on a total of five identical homework assignments given to the two course sections during the semester.

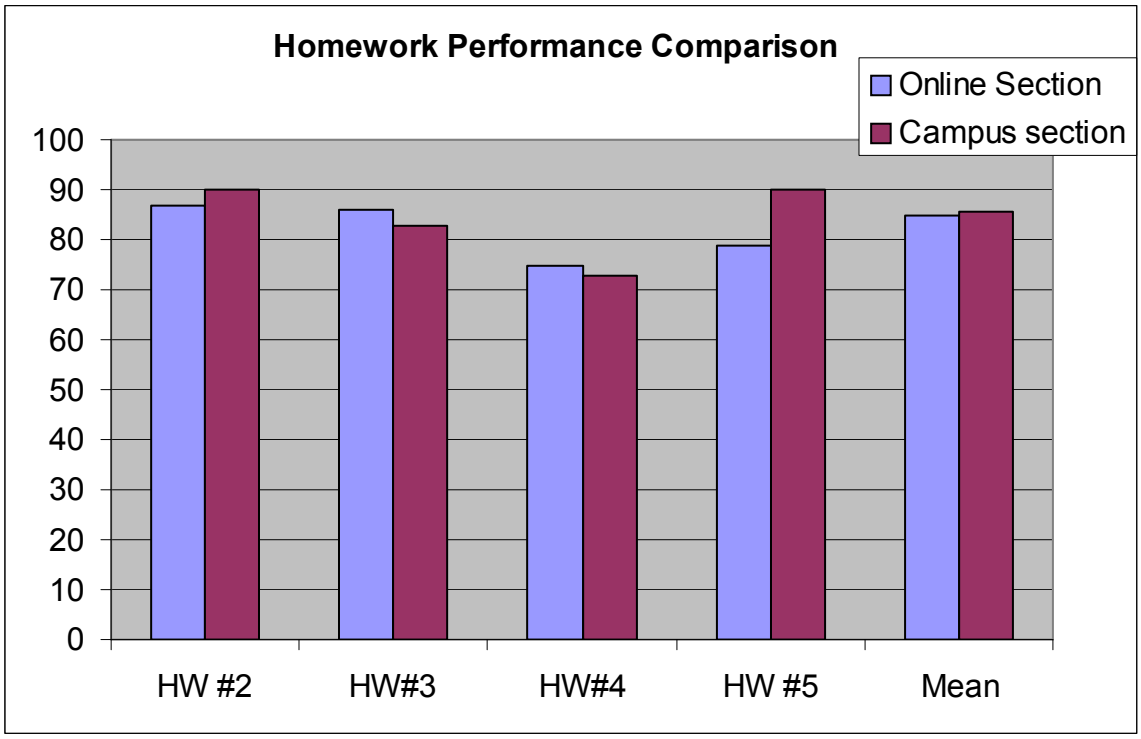


Figure 13: Homework Performance Comparison

The homework and labs were done under similar conditions with the students given one or two weeks to complete each assignment. As Figure 13 shows, there was no significant difference in performance. Figure 14 shows a significant difference in lab performance (hands-on projects). It is likely that the on-campus students spent more time on the projects than online students.

The performance on the tests was also compared. As shown in Figure 15, it was found that the results were comparable except for test #2. Test #2 was focusing on engineering mechanics. The reason for this discrepancy may be the difference in background of the students in the two sections.

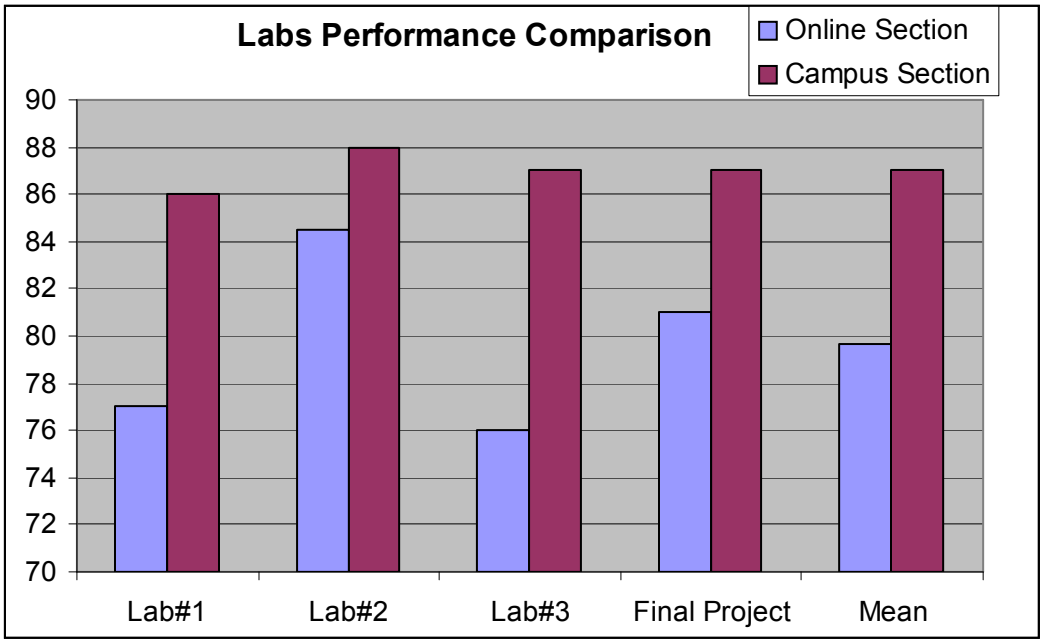


Figure 14: Lab Performance Comparison

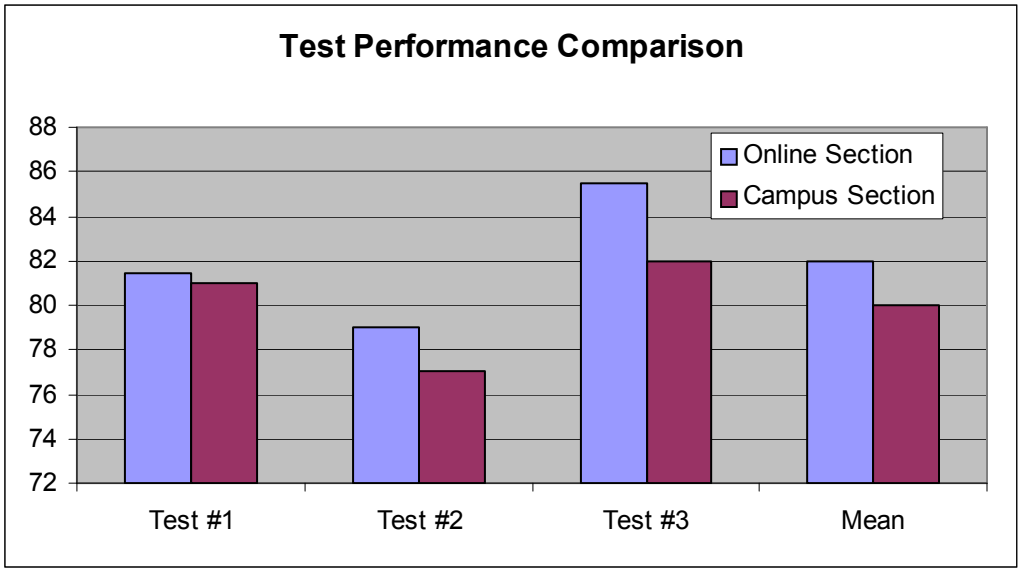


Figure15 Test Performance Comparison

The comparable performance in the tests was particularly interesting. The conditions for taking quizzes were quite distinct for the two course formats. The tests were available for twenty-four hours on the test dates for the online course and administered in class for the traditional format section. Quizzes had a time limit that was designed to be sufficiently restrictive to prevent the students' answering questions by spending a lot of time looking up the material in the text. Students were only allowed one attempt for a quiz and had to complete it within the specified time limit[1].

8. Conclusion

In the last four semesters, an online Introduction to Engineering Course has been developed and taught at the University of New Haven in the School of Engineering and Applied Sciences. While the online course of ES107 appeals to many students due to the flexibility and convenience it offers, not all students are suited to online learning. The course assessment shows that the online courses should be offered only for those students who have the necessary self-discipline and study skills, and are somewhat proficient in computer usage. Online courses should be targeted to independent, motivated learners, who want an alternative to face-to-face teaching.

The majority of online students are able to learn the material as effectively as the traditional student but have the added flexibility and convenience to obtain information in or out of the classroom. According to the students' comments, they consistently enjoy the new teaching method and like the flexibility.

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Biographical Information

ISMAIL I. ORABI, Professor of Mechanical Engineering at University of New Haven. He received his Ph.D. from Clarkson University, and his MS degree from the State University of New York and B.S. from Cairo Institute of Technology (now Helwan University), all in Mechanical Engineering. He has published over 25 technical articles in refereed journals and conference proceedings. His research interests include theoretical and computational investigation in the area of mechanical vibrations and dynamic systems and control. Professor Orabi has taught courses in both undergraduate and graduate level Mechanical Vibrations and Multimedia Engineering Analysis, and undergraduate level thermodynamics, Measurement Systems, Engineering Mechanics and Introduction to Engineering. One of Professor Orabi's most recent projects involves the development of Learning Modules on the web. These modules provide information, not only about particular course material, but also about more general topics relevant to engineering. He is also working on Computer-Aided Experimentations using LABVIEW. Professor Orabi has received a number of research awards from the State of Connecticut and Untied Technologies. He has established two Laboratories: the Materials Testing laboratory sponsored by the National Science Foundation, and the Engineering Multimedia Laboratory funded by AT&T. He is a member of ASME and ASEE.