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Hybrid Course Design: Leading a New Direction in Learning Programming Languages

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AC 2012-4754: HYBRID COURSE DESIGN: LEADING A NEW DIRECTION IN LEARNING PROGRAMMING LANGUAGES

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Hybrid Course Design: Leading a New Direction in Learning Programming Languages

Embry-Riddle Aeronautical University

Abstract

"Introduction to Computing for Engineers" is a programming course emphasizing problem solving. The lack of practice time, in addition to the algorithm-centric nature of programming, results in an inadequate comprehension of course material. In the fall of 2010, three faculty members created and implemented online activities consisting of video lecture slides, and mini on-line quizzes at Embry-Riddle Aeronautical University to give students more "hands-on" learning (rather than expecting them to absorb content through lecture). Students do online lecture study by themselves, then come to the lab to practice on the following day with the instructor and teaching assistant. In the fall of 2010, four out of ten sections were delivered using hybrid instruction. Analysis of exam results at the end of the semester showed no significant distinction between hybrid learning and traditional study. Feedback received from the students indicates that the majority of students preferred the hybrid course over the traditional course. Students who took the hybrid course during this semester are happy with their hybrid experience. These positive results encouraged faculty members to increase the number of hybrid sections to four during the spring of 2011 and the fall of 2011 semesters. The hybrid course design and course-wide assessment continued.

In this paper, improvement of the online video design is introduced, and assessment results are presented. It is believed that by switching from a traditional classroom environment to a hybrid learning, student comprehension of the course content will improve, in addition to their interest and subsequent retention in engineering.

Keywords: Hybrid, MATLAB, programming, computing, online.

Introduction

"Introduction to Computing for Engineers" (EGR115) is one of largest classes in the Freshman Engineering department at Embry-Riddle Aeronautical University at Daytona Beach, with an average enrollment of 500 students each year. Since the course is typically taught during the freshman year, ensuring that students have sufficient programming background for solving problems in other engineering courses, there is no prerequisite to this course. The course's main issue is the lack of practice time. Combined with the algorithm-centric nature of programming, this results in inadequate comprehension of the course material. The course has been revised multiple times in response to comments from students and faculty. One of the most significant changes was switching from programming in C to programming in MATLAB in the fall of 2009, since MATLAB has become the major language used in various engineering disciplines for problem solving [1, 4, 5]. Following this, the course changed its meeting time from three times a week to four times a week. It now uses a 2+2 format: two days of lecture per week, with each lecture day followed by laboratory time to facilitate material understanding by hands-on practice. Approximately 120 students will attend one-hour lecture in an auditorium. The following day,

students attend a small lab session, usually 26 students, to allow more contact with each student while s/he practices. The course is three credit hours.

There has been concern voiced regarding large lectures with respect to attendance rates, effectiveness of large lecture instruction, and connectivity between the instructor and students. To provide a more flexible learning environment and improve student learning outcome [2, 3, 6], starting in the fall of 2010 under the assistance of Center for Teaching and Learning Excellence (CTLE) at Embry-Riddle Aeronautical University a hybrid version of the course was implemented. The hybrid sections are delivered on the regular basis each semester after our successful initiation. The general format of the hybrid and traditional remains the same: 2 hours of lectures per week and 2 hours of lab time per week. However, in the hybrid course, each 1-hour lecture time spent in the auditorium is replaced by online self-study activities which also last one hour. Thus, instructor and students only meet face-to-face twice a week, during the lab time to solve student's problems and help them with hands on practice. The self-study online activities consist of watching recorded audio-visual PowerPoint lectures, joining online discussion, and completing exercise/quizzes before each face-to-face lab time. It is believed that with 24/7 unlimited course content access online, students have more flexibility to learn at any time as often as they want. It also improves connectivity between the instructor and students with greater use of emails, online discussion, and virtual office hours supplementing class time and real-world office hours.

There are around 300 students enrolled in EGR115 each semester, divided in ten smaller sections. Starting the fall of 2010 semester, 40% to 50% students were enrolled in one of the four to five hybrid sections, while the others remained in traditional classes. During enrollment, most students had no knowledge as to which course delivery type a section would be, and no privilege was given to any students (for example high SAT scores) as far as taking the hybrid course over the traditional. This was done to ensure the data would be statistically similar for assessment purposes.

To assess the existing and new hybrid course, two surveys, data regarding tutoring time, and exam scores were collected and analyzed each semester from fall of 2010 to fall of 2011, as presented in this paper. Overall, positive feedback was received from students regarding the hybrid course design at the end of the semester.

Course structure

Online module

The online content module (delivered under Blackboard 9) consists of audio over PowerPoint slides, self-assessment quizzes, and the use of Facebook as an online communication tool, as shown in Figure 1 and Figure 2. The content of the PowerPoint presentations is identical for both traditional and hybrid students. However, for the hybrid courses, each PowerPoint presentation has been split into smaller 10-20 minute presentations, so that students can allocate their time according to their own schedules. Audio was added to each PowerPoint, originally recorded using Adobe® Captivate™ . Since summer 2011, the presentations have been improved by introducing a more visually stimulating environment. The first audio-over-PowerPoint presentations are mostly static. Using Camtasia Studio 7.1 to record the screen itself, the

presentations now show code being typed, errors being made and fixed, and MATLAB code executed in real time. Camtasia Studio 7.1 allows callouts to be inserted - such as keys pressed (see Figure 3(a)), boxes drawn to emphasize text, highlighting, or magnify part of the screen to focus on a specific point.

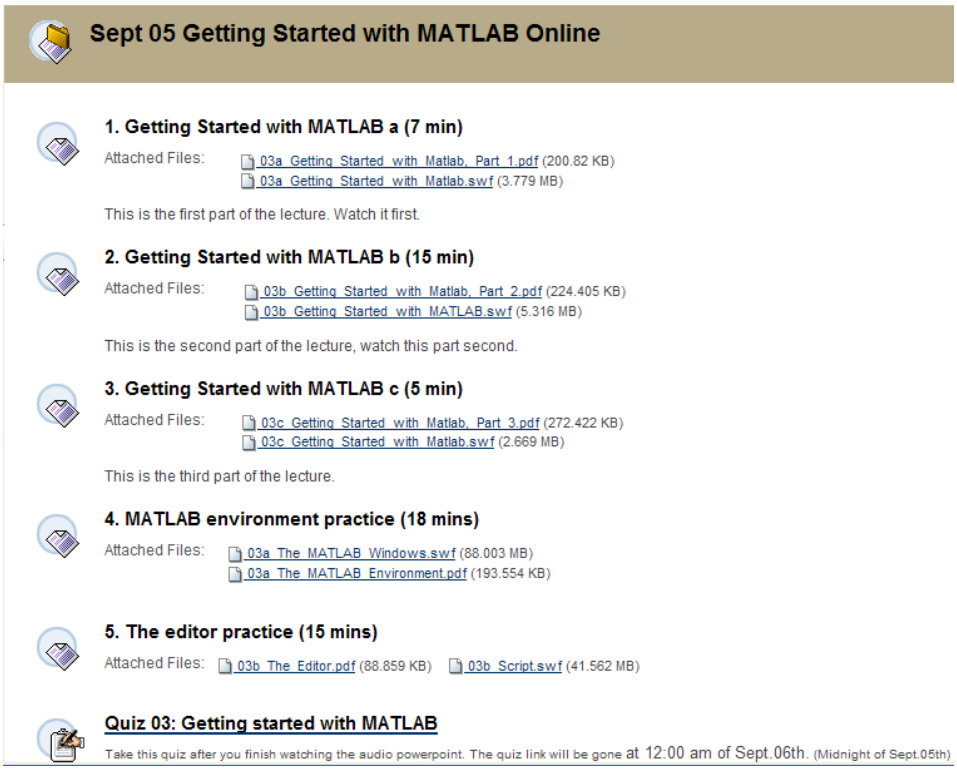


Figure 1. A screenshot of online activity on Blackboard

Students see the overall lesson as a video (.swf file extension). This type of delivery allows and encourages students to pause and test code examples from the slides on their own computer, and to answer several short quiz questions (multiple-choice format) which review the important concepts of the lesson (shown in Figure 3). Multiple choice questions are also implemented within the audio files, where students receive immediate feedback when they enter their answers. These quizzes are for self-testing only, as the score is not recorded. Students can watch the video and take the quizzes as many times as they wish. After each video study, students answer ten multiple-choice questions on Blackboard to check their understanding of key study points in the lecture slides. Students need to take this quiz during the online study day and no later than midnight. This quiz can only be taken once and the feedback is given immediately. The score is recorded into the Blackboard system and counts up to ten percent of the final grade. After the quiz, one to two self-exercise programming questions may also be assigned to help students practice what they have learned. The programming questions are from the slides and only minor changes are made to insure students can complete it within a brief time. Students must complete and submit these online before the lab practice starts on the next day. Since the spring of 2012, all material is organized in folders and available on the first day of classes. This allows curious students to watch the lessons ahead of time if they wish to do so.

Figure2. A screenshot of online communication on Facebook

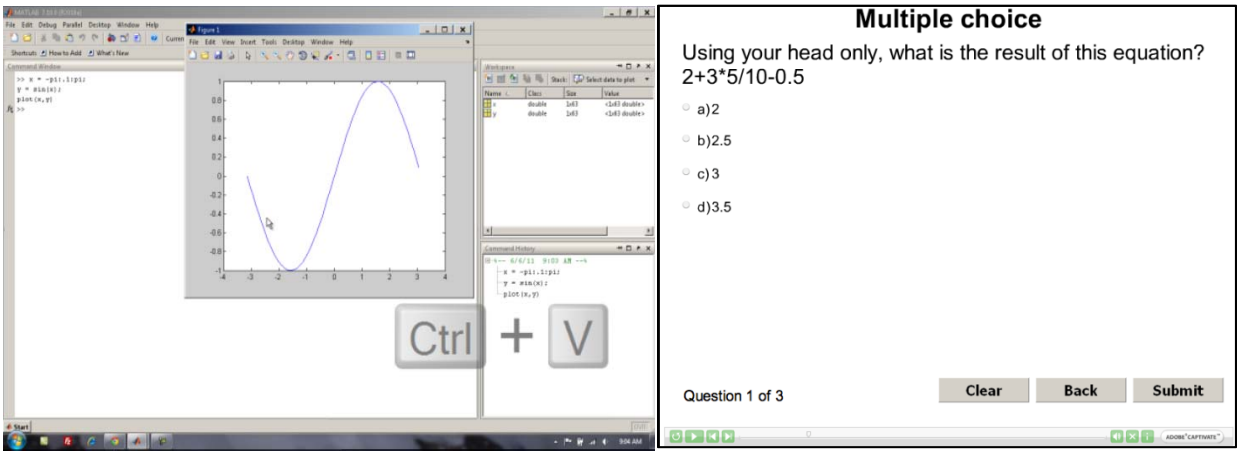


Figure 3. Screenshots of audio PowerPoint presentation (a) captured from Camtasia Studio 7.1 (b) captured from Adobe® Captivate™

Lab practice

Face-to-face lab practice time is used to augment the online content: students present questions (to the class or one-on-one with the instructor) regarding the content. Interaction with other students provides both peer assistance and incentive to progress. Instructors are better equipped to assist students with the exercises during class time as opposed to a lecture period. When exercise topics are simple, various little programs are given. A "show-me, let-me" method is used. The instructor solves a small problem in front of the students, then a similar problem is

given to them for them to solve on their own during the lab time. When topics become more significant, the show-me part is mostly done in the lecture slides. The "let-me" portion is entirely done in the lab where the instructor explains the major points of the assignment only. Whatever is not completed in lab time is work to finish at home. Regardless of whether it is a minor or more important topic, the work is graded.

Course assessment

Surveys

Thus far, two surveys are administered during the semester. The first survey is meant to evaluate the student's "level of friendship" with computers in general - to make sure the hybrid course is delivered in an appropriate way. This survey was given to both traditional and hybrid sections. The results from fall of 2010 to spring 2012 are summarized in Table 1 shown. The response rates for fall 2010, spring 2011, fall 2011, and spring 2012 are respectively 84%, 74%, 87%, and 74%.

Table 1. Computer-Familiarity survey results

General questions given in the first survey	Percent (%)			
	Fall 2010	**Spring 2011**	**Fall 2011**	**Spring 2012**
Comfortable with computer for daily use	99.6	99.0	99.3	99.5
Comfortable with Microsoft Window or Mac OS X to run programs or manage files	95.9	92.9	95.7	97.1
In either Window or OS X system, knowing how to use keyboard shortcuts for copy, past, and cut	80.5	82.7	78.2	84.5
Know the differences between the words "system", "CPU", and "hard drive".	76.3	75.1	71.0	81.2
Know the difference between "the Internet" and "the World Wide Web".	50.2	53.8	47.5	52.7
Know how to use word processing program (like Word, WordPad, TextEdit) before.	97.9	95.4	97.0	97.6
NEVER created a program for my computer or calculator.	53.1	58.4	58.7	53.6
Worked with MATLAB before taking this class.	10.0	20.3	8.6	15.9

The survey suggests that students as a whole are comfortable working with the operating system of their computer - either Microsoft Windows, or Apple OS X. In fact, less than 5% express doubt regarding this. Anecdotal evidence suggests that this number might be slightly optimistic compared to actual abilities, but a reasonable approximation. The survey attempts to "pin down" some expectations of a person who is familiar with an operating system. Use of keyboard shortcuts and familiarity with terminology such as "clipboard", "CPU", "hard drive", etc. are used as indicators for familiarity. For example, while 95% on average express comfort working with their operating system, 20% on average cannot state with confidence that they use the

keyboard shortcuts for cut, copy, and paste - a daily-use skill for a person truly familiar with an operating system. Our analysis of this survey suggests that students are "comfortable" with using the computer for simple tasks - typically involving the web browser - but are not as capable as they might believe. So, when the course requires the use of new tools such as Blackboard, ZIP files, or Citrix applications such as Network File Access, the instructors end up teaching much more than the curriculum of the course because students have never observed these tools in use, let alone applied them personally.

With respect to programming familiarity, surprisingly 44% of students believe they have programmed in some fashion. The level of programming might just be a calculator program, but this is a nice beginning for those that have truly done so. Because these students have had to learn fundamental concepts of programming such as memory and variables, input and output, and possibly even flow control, the efforts toward the beginning of the semester are more reinforcement than new exposure. It is unfortunate that 53% admit no programming experience at all and therefore the early course speed must be restrained so that these students can still be kept in the class. It is interesting to note that although the new generation is constantly referred to be more technical-savvy, the numbers over the past two years have not correlated that idea. The second survey is meant to evaluate the overall satisfaction of the hybrid experience, and was given only to the hybrid sections. Student response to the second survey is summarized here.

Table 2. Hybrid-satisfaction survey student response

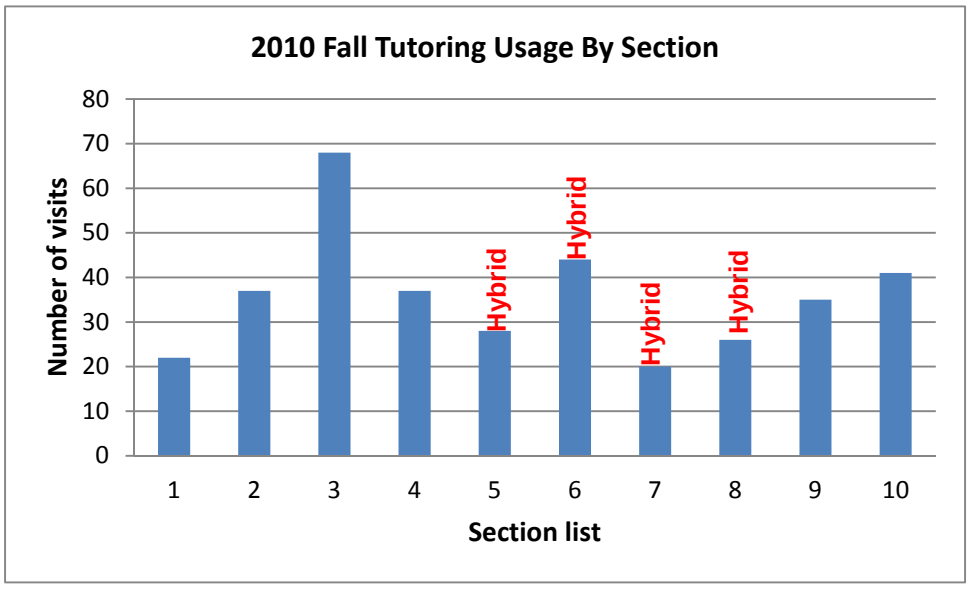
General questions given in the second survey	**Percent %**		
	Fall 2010	**Spring 2011**	**Fall 2011**
Possess sufficient technical proficiency to complete online components.	92.9	85.1	89.3
Have the self-discipline needed to succeed in hybrid courses.	88.1	92.6	86.4
Have the self-motivation needed to succeed in hybrid courses.	85.7	85.1	82.4
Learn as well in hybrid courses as in traditional face-to-face courses.	52.4	70.3	62.3
The online activities help me to learn essential material in the hybrid course.	64.3	92.3	69.1
Like to enroll in another hybrid course.	64.3	77.7	66.5
Like using technology in my learning experiences.	88.1	85.2	86.0
At the beginning of the course, I was provided the information I needed to understand what the hybrid course experience would be, and I was provided information that indicated what was expected of me.	78.6	88.9	88.3

Generally, students are confident with skills they need for the online study. This echoed the results from the first survey. New generations are not afraid of experiencing new technology, but can overestimate their ability. At the beginning of the semester, students frequently asked how to transfer a file from their personal computer to their "P" drive on the server; how to obtain screenshots; and how to create a ZIP file. Meanwhile, as freshmen, they are still afraid of self-learning, and the lack of interaction with other students and the instructor. They doubted if they should enroll in another hybrid course if offered. They accepted Introduction to Computing for Engineers as a hybrid course, since it is a computer related course in the first place.

From student comments, mostly positive feedback was received. They enjoyed the flexibility of the schedule, the rewind and pause feature of the video study, and the convenience and freedom to work at their own pace. The negative comments resulted from the lack of immediate communication with classmates and professors, and some fast and unclear explanation of material. Overall students in hybrid sections reported high-level satisfaction with hybrid experience.

Tutoring time

During the semesters discussed, tutoring was offered five evenings a week: Sunday through Thursday from 7 PM to 10 PM. (This has since been expanded). Most times, two tutors were available in the computer lab, but occasionally 3 tutors were available to meet the demand. The tutoring is provided by previous students who have taken the class. These students either were excellent in the class, or came with previous programming knowledge from another institution. Most student tutors are sophomores or juniors. Tutoring hours used from fall of 2010 to fall of 2011 were collected and are presented in Figure 3 below. Attendance was recorded for each student and was mapped to their respective sections. From the graphs, it can be seen that there were fewer students from hybrid sections using tutoring time than those from traditional sections. Since students from traditional sections obtained less exercise time as compared to students from hybrid sections, it is believed that the online quizzes after audio lectures and in-lab exercise helped hybrid students grasp the material better and use less tutoring time.



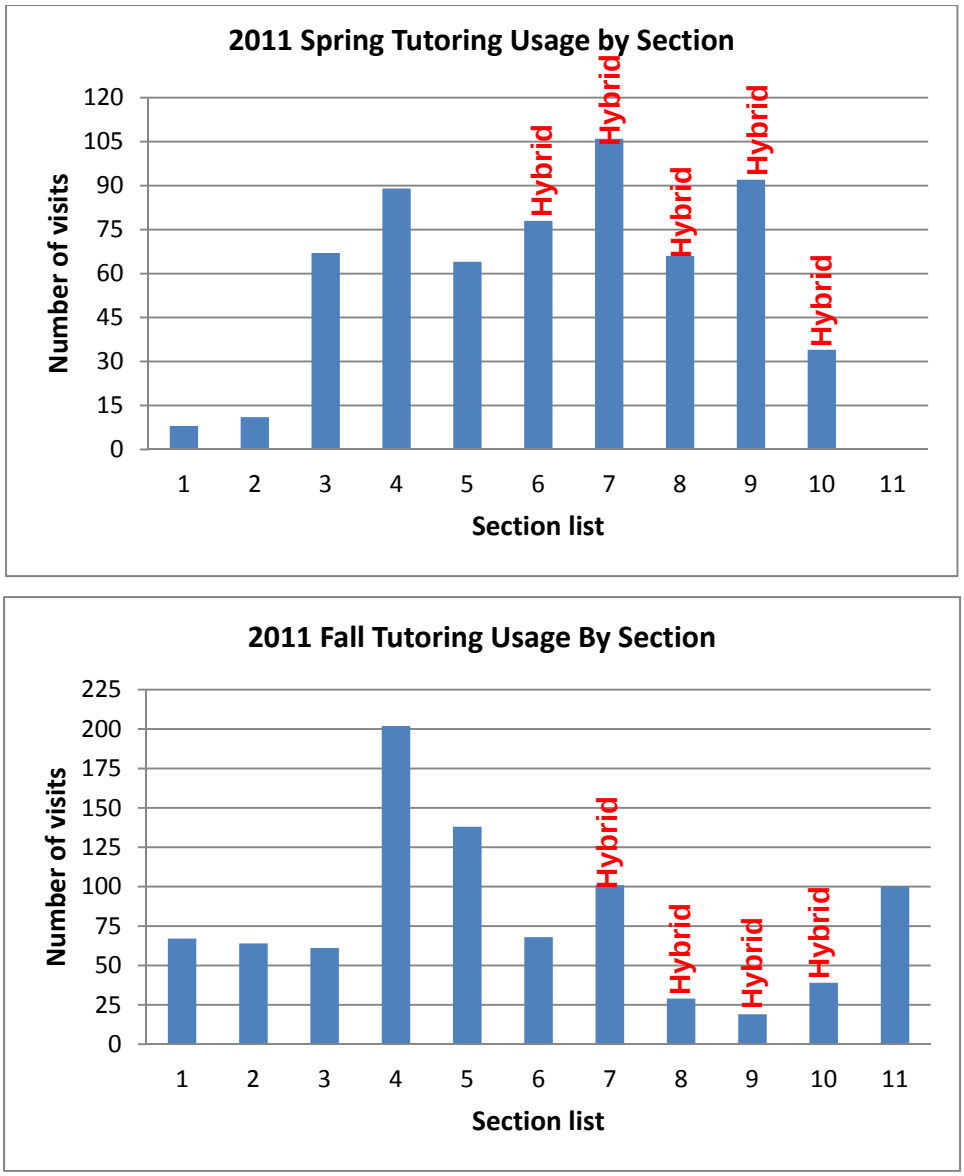


Figure 3. Tutoring hours used by each section from fall of 2010 to fall of 2011

Facebook

Before the implementation of our use of Facebook, a discussion board on Blackboard was used to answer student questions and to allow students to exchange their experience. The discussion board on Blackboard turned out to be an unsuccessful experience since students only checked Blackboard when there was a necessity. When they did not see many messages posted, they gradually lost interest in posting or even reading others' posts.

Online communication is still an essential tool to increase interaction between students and the course instructor. After a discussion with students, a well-known communication tool amongst students - Facebook – was chosen. A closed group account allows all students from the instructor's sections to join, post, comment, and chat in this online community. The account is

monitored by the instructor and the teaching assistant in order to guarantee that each question is answered in a timely manner. To date, there were over 300 messages posted from two hybrid sections. These posts covered discussions about the homework, quizzes, technical problems, and the learning experience, as well as seeking answers to assigned questions. In addition, instructors may post links about research opportunities within the college, internships, and current events about MATLAB. This shows students that what they are learning is useful for internship opportunities, and is being used in the industry. This helps in their interest in the class, and therefore their success. It also helps reduce the 'lack of interaction' with the faculty; when students are suddenly interested by the opportunities, they come forward to talk with the faculty about the post.

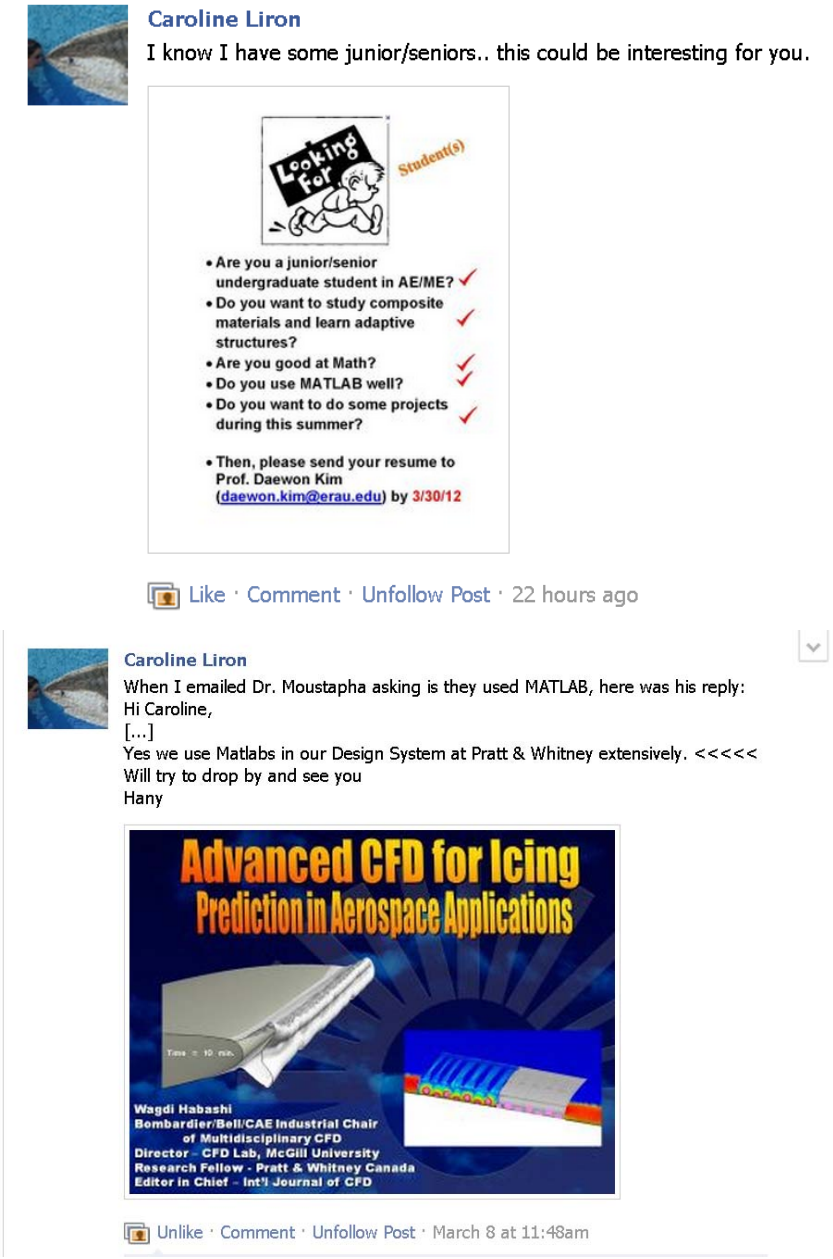
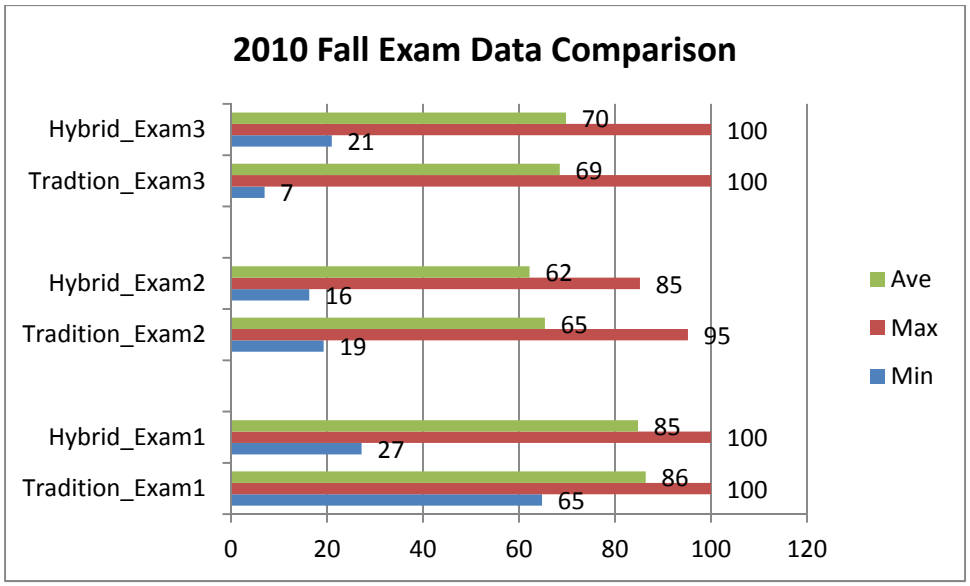


Figure 4. MATLAB related messages on Facebook group page

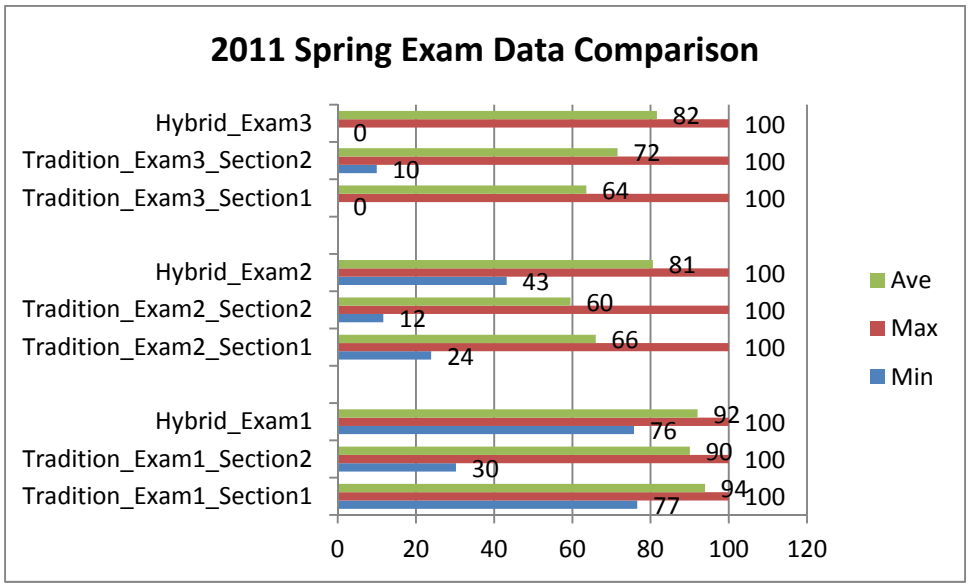
Exams

A full week is given per exam. The two lectures are designed to comprehensively review the course topics. A PowerPoint of topics from which to study combined with multiple-choice questions is shown. All students were encouraged to attend the face-to-face lecture review in the lecture hall. Also during this week, two lab sessions are available which include one Practice Exam (lab session 1), and one Real Exam (lab session 2). Students are asked to answer multiple-choice questions (10-30% of the grade) and to provide a programming solution to an assigned problem (70-90% of the grade). Students plan their time accordingly within the one-hour class time to complete both. Another approach is to use the first lab session as a small-class review, encouraging the students to be more vocal than they might in a large lecture. Students are encouraged to prepare for the review session and bring pertinent questions from their studies. Practice exams are reviewed, with rationale given for the answers. The second lab session is broken down into a short (20-30 questions) multiple-choice / short-answer section online and a longer programming portion on paper. The multiple-choice section is a typical "closed resource" exam; the programming portion is "open resources" books, notes, Internet, etc except for communication with other people.

Figure 5(a) and (b) show the comparison of exam statistics data between traditional sections and hybrid sections from one instructor given in fall 2010 and spring 2011 individually. Because each instructor designed his/her own exam questions, the difficulty level could be different, which could result in the different grade distribution. So the exam scores including the maximum, the minimum, and the average from one instructor, who taught hybrid and traditional sections during the same semester were analyzed. From the scores obtained from each exam in each section in the fall of 2010, it can be seen that there is little difference between the hybrid and the traditional sections. From the spring of 2011 data, the scores obtained from the hybrid section are better than the scores obtained from the traditional sections. This assessment tells us that switching to the hybrid section will not hurt students' scores. As the instructors continue to improve the quality of the video and the format of the delivery, it is believed that student performance will improve and probably exceed the performance of the students in the traditional sections.



(a)



(b)

Figure 5.Three exams statistics data comparison between hybrid and traditional sections from one instructor in two semesters

A common final exam is given to all students who take EGR115 at the end of the semester. The exam consists of 30 common questions which cover the major course outcomes, along with 40 to 50 questions covering all topics of the semester. The questions are either multiple-choice questions or true-false questions. The ultimate goal of the common final exam is to ensure that all students who completed the course are exposed to the same content. In Figure 6, the common final exam data collected across 10 sections in fall 2010 and spring 2011 are presented. The red line shows the average score of the questions across 10 sections. In the fall of 2010, the average scores of the common final exam from all four hybrid sections are above the average score line. In the spring of 2011, average exam scores from 3 out of 5 hybrid sections are above the average

score line. Overall the students in the hybrid sections successfully complete course study and demonstrate an above-average performance compared to the traditional section students.

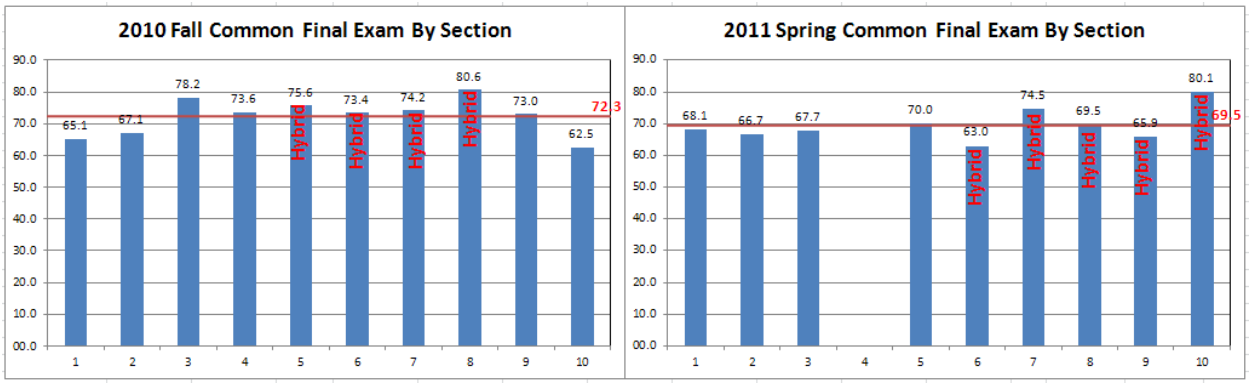


Figure 6.Common final exam data comparison by sections in fall of 2010 and spring of 2011

Conclusion

A hybrid course called “Introduction to Computing for Engineers” was developed and delivered starting in the fall of 2010. The course was split into online lecture activities and in-lab programming practice on the following day with instructor and teaching assistant. Different assessment methods were presented.

As a whole, it is pleasing to note that switching to hybrid has not been detrimental to the students in any way. Web-based design can give students more flexible time to study at their own pace, leaving more face-to-face class time for hands-on practice. From the tutoring time recorded, it has been noted that students in hybrid sections used less tutoring help compared to students in traditional sections because of the intensive online quizzes and in-lab practice. The analysis of the exam results shows that there is no significant distinction between hybrid learning and traditional study. The survey results reflected the growth of students’ computer knowledge and the acceptance of new technology application to today’s classes.

It is believed that with continuously improving instructional videos, assessment methods, use of up-to-date technology, hybrid design in the course will be accepted by more students, and provide a more effective way of self-learning and interactive laboratory practice experience as compared to traditional classroom style.

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