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The Path of Innovation: from Traditional Classroom to Hybrid Experience

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The Path of Innovation: from Traditional Classroom to Hybrid Experience

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Abstract – "Introduction to Computing for Engineers" is a programming course emphasizing problem solving. However, the lack of time for practice and the algorithm-centric nature of programming results in inadequate comprehension of this course material. Through course evaluations, faculty experience, and discussions, we feel that students in a programming course should have more time for "hands-on" learning, rather than trying to absorb content through lectures. We believe that by getting students involved and excited about engineering from the beginning of their first year, we will markedly improve comprehension of the course content. To that end, a hybrid course is implemented that involves the creation and implementation of online activities, incorporating student-paced active learning and evaluation modules and in-class student implementation/demonstration. The objective is to enhance student involvement in the learning process, as well as to improve interest and 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 a year. Since the course is typically taught during the freshman year to ensure that students have sufficient programming background for solving problems in other engineering courses, there is no prerequisite to this course. The main issue with this course is the lack of time for practice, and the algorithm-centric nature of programming results in an inadequate comprehension of this course material. The course has been revised from time to time, according to comments from students and faculties. One of the most significant changes was switching from programming in C to programming in MATLAB in fall of 2009, since MATLAB has become the major language used in various engineering discipline 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 a laboratory practice to facilitate material understanding by hands-on practice. Around 100 students will attend one-hour lecture in an auditorium. Then students disperse to each small lab session, usually 26 students, to allow more contact with each student while they practice. 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], we have attempted the implementation of a hybrid version of the course for the fall of 2010 under the assistance of Center for Teaching and Learning Excellence (CTLE) at Embry-Riddle Aeronautical University. The general format of the hybrid and traditional remains the

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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 anytime 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. During the fall of 2010, a total of 288 students were enrolled in EGR115, divided in 10 smaller sections. 112 students (40%) were enrolled in four hybrid sections, while the others remained in traditional classes. During enrollment, 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 the purpose of assessment purposes.

To assess the existing and new hybrid course, two surveys, data regarding tutoring time, and exam scores were collected and analyzed, as presented in this paper. Positive feedback was overall 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, short exercise questions, chat window, and a discussion board, as shown in Figure 1 below.

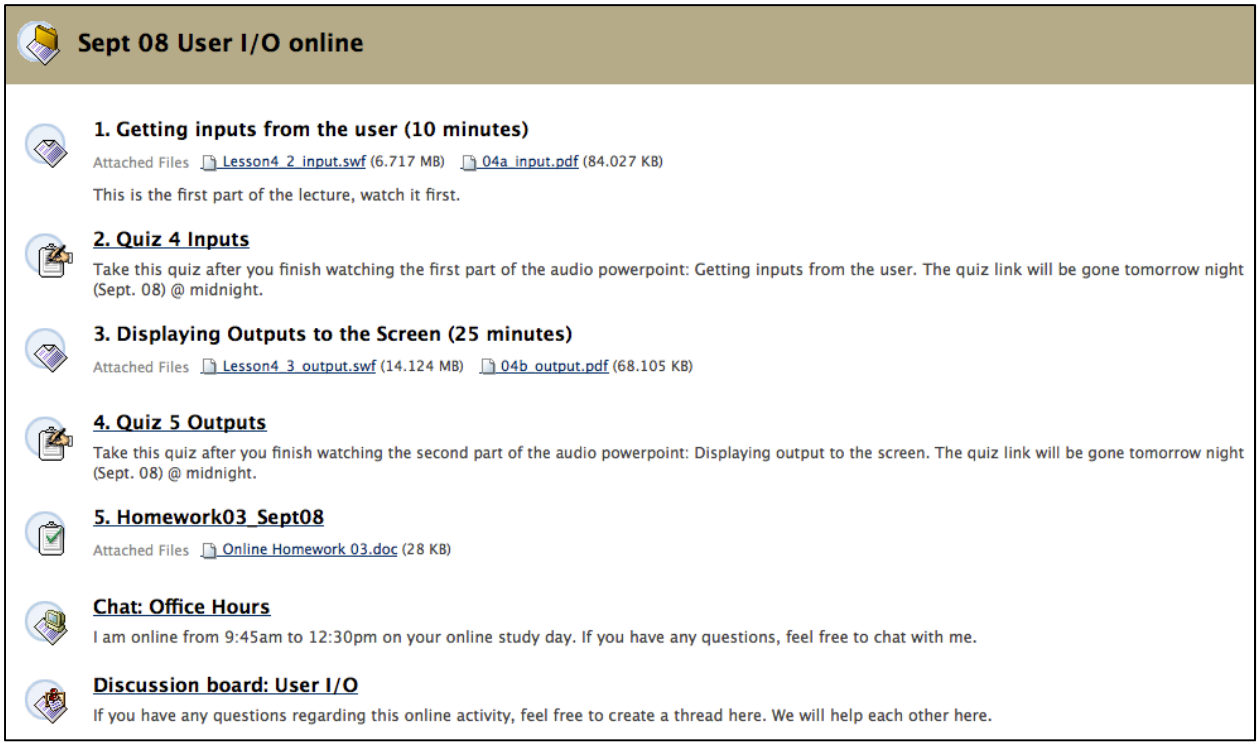


Figure 1. A screenshot of online activity on Blackboard

The content of the PowerPoint presentation is identical for both traditional and hybrid students. However, for the hybrid courses, each PowerPoint presentation has been split into two or three 10-20 minute long smaller PowerPoint presentations, so that students can allocate their time according to their own schedule. Audio has also been added to

each PowerPoint, recorded using Adobe® Captivate™. 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, as well as to answer several short quiz questions (multiple choice format) reviewing the important concepts of the lesson, as shown in Figure 2. The students can receive immediate feedback when they enter their answers. The quiz in the video is for self-test only, as the score is not recorded. Students can watch the video and take the quizzes as many times as they want. After each video study, students answer ten multiple-choice questions on Blackboard to check understanding of key study points in the lecture slides within a specifically allocated time. Students need to take it during the online study day no later than midnight. This quiz can only be taken once and the feedback is given right away. The score is recorded into the blackboard system and counts up to 10 percent of their final grades. After the quiz, usually a one to two self-exercise programming questions can 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 self completion in a short time. Students must complete and submit these online before the lab practice starts on the next day. Meanwhile, a chat window and a discussion board are provided for immediate online assistance. Each online module is available online at least one day before the students' scheduled exposure.

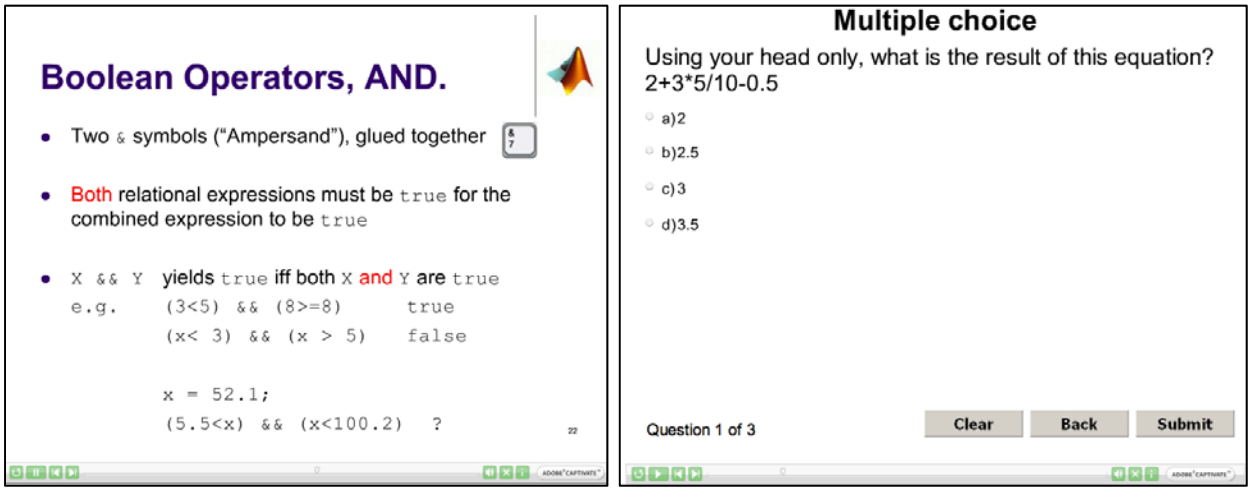


Figure 2. Screenshots of audio power point presentation.

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 and 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. When exercise topics are small, 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. The instructor only explains out loud the major points of the lab. Whatever is not completed in lab time is given to finish at home. Regardless of whether it is small or more important topic, the work is graded.

COURSE ASSESSMENT

Surveys

Two surveys have been administered at this time. 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. A total of 241 students (84%) responded to the survey. The results are summarized in Table 1 shown next page.

General questions given in the first survey	**Percent (%)**
Comfortable with computer for daily use	99.6
Comfortable with Microsoft Window or Mac OS X to run programs or manage files	95.9
In either Window or OS X system, knowing how to use shortcut for copy, past, and cut	80.5
Know the differences between the words "system", "CPU", and "hard drive".	76.3
Know the difference between "the Internet" and "the World Wide Web".	50.2
Know how to use word processing program (like Word, WordPad, TextEdit) before.	97.9
NEVER created a program for my computer or calculator.	53.1
Worked with MATLAB before taking this class.	10

Table 1. First survey results

The initial 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, only about 3% 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 97% express comfort working with their operating system, almost 20% 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 our course requires the use of new tools such as Blackboard, ZIP files, or Citrix applications such as Network File Access, we 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, we are pleasantly surprised to learn that 44% believe they have programmed in some fashion. The level of programming might be just 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, our efforts toward the beginning of the semester are more reinforcement than new exposure. It is unfortunate that we have 53% who admit no programming experience at all and we therefore must (and do) restrain the early course speed so that we don't lose these students.

The second survey is meant to evaluate the overall satisfaction of the hybrid experience, and was given only to the hybrid sections. Only 42 students (35%) responded to the survey due to the short exposure time. Of these students, 35 were freshman (83.33%) and 7 were sophomore (16.67%). Since it is a freshman course, the distribution is as expected. 32 students (76.19%) had never taken an online or hybrid course before.

Student response to the second survey is summarized here:

General questions given in the second survey	Percent (%)
Possess sufficient technical proficiency to complete online components.	92.85
Have the self discipline needed to succeed in hybrid courses.	88.09
Have the self motivation needed to succeed in hybrid courses.	85.72
Learn as well in hybrid courses as in traditional face-to-face courses.	52.38
The online activities help me to learn essential material in the hybrid course.	64.29
Like to enroll in another hybrid course.	64.29
Like using technology in my learning experiences.	88.09
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.	78.57

Table 2. Second survey student response.

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 could overestimate their ability. At the beginning of the semester, students frequently asked about how to transfer a file from their personal computer to P drive under the public network, how to do screenshots, and how to zip a 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, we obtained mostly positive feedback. 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

Tutoring is offered five evenings a week: Sunday through Thursday from 7 PM to 10 PM. Most times, two tutors are available in the computer lab. At times, 3 tutors are 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 are sophomores and juniors. Tutoring hours used from 09/01/2010 to 12/01/2010 were collected and presented in Figure 3. All students who came to ask questions could be recorded in their respective section. From the graph, we can see 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.

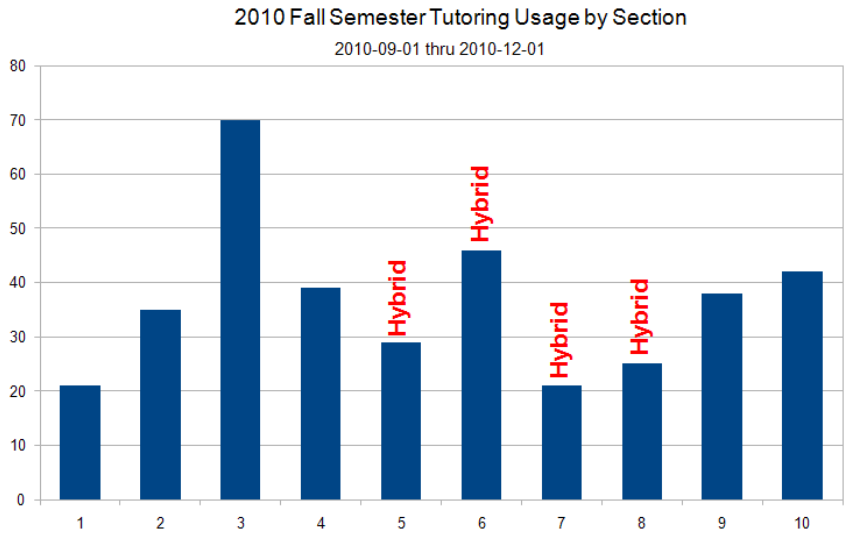


Figure 3. Tutoring hours used by each section from 09/01/2010 to 10/18/2010.

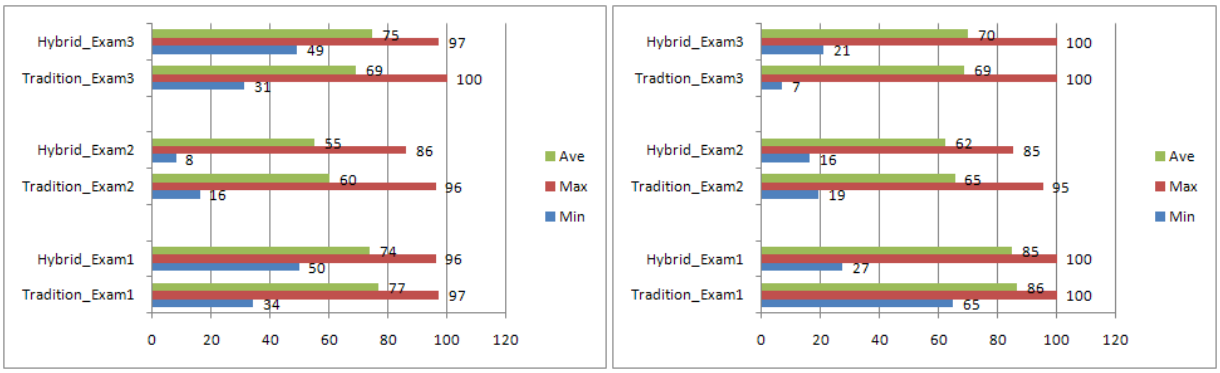
Discussion board

A discussion board is used to answer student questions, and to allow students to exchange their experience. It is an essential tool to increase interaction between students and the course instructor. The board is monitored by the instructor and the teaching assistant in order to guarantee that each question is answered in time. The forums were created according to the topics covered in each week, e.g. library functions, loops, array, files etc. To date, from two hybrid sections, there were 98 messages posted, which covered questions about the homework, quizzes, and the hybrid experience, as well as answers to the questions.

Exams

A full week is given per exam. The two lectures are designed to review comprehensive knowledge. A PowerPoint of topics to study from combined with multiple choice questions is shown. All students were encouraged to attend the face-to-face lecture review, which included multiple-choice questions, in the lecture hall. Each week, two lab sessions are available, which includes one Practice Exam (lab session 1), and one Real Exam (lab session 2). Students have to answer multiple-choice questions (20-30% of the grade) and program (70-80% 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 4 (a) and (b) show the comparison of exam statistics data between traditional sections and hybrid sections from two instructors individually. Because each instructor designed his/her own exam questions, the difficulty level could be different, which could result in the different grade distribution. But, generally average scores from the hybrid section catch up the scores from traditional section after the second exam, and is better on the third exam. Both minimum scores from hybrid sections from two instructors are higher than that from the traditional sections. This assessment tells us that students need time to adjust the hybrid experience. Gradually, hybrid students learned how to manage their time and pace to grab more knowledge from online activity compared to traditional students. Since most students are freshman, they may need more time to adapt to hybrid learning than junior or senior level students.



(a) (b)

Figure 4. Three exams statistics data comparison between hybrid and traditional sections from two instructors.

CONCLUSION

A hybrid course called "Introduction to Computing for Engineers" was developed and delivered 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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