

The Effects of Transitioning from a Face-to-Face Fundamentals of Engineering Review to a Virtual Environment

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The Fundamentals of Engineering (FE) Exam is one of the first steps in becoming a licensed professional engineer. Universities have strongly encouraged, and in some cases required, students to take the exam prior to graduating with their bachelor's degree. The exam covers a multitude of subject areas that are explored throughout the undergraduate curriculum. Review sessions, online or face-to-face, may be offered by the institution to assist seniors in preparing for the exam.

This case study looks at a senior-level FE Preparation course taught within the College of Engineering at the University of Texas at Tyler. Prior to the Fall of 2014, review content for the FE exam was covered in a face-to-face environment. Now, a required zero credit hour course has been developed where all review content related to each of the three disciplines of engineering at UT Tyler (Civil, Mechanical and Electrical) has been posted online for students to review on their own. This paper analyzes the pass rate of 5 senior civil engineering graduation classes spanning from 2012-2016 which is prior to and after the change in course format. Based on the data available to date there does not appear to be a negative effect of the transition for the civil engineering students.

Introduction

Advances in technology has brought alternative methods of delivering course content beyond the traditional face-to-face lecture format. Fully online and hybrid courses are becoming more frequent as to provide a flexible learning/teaching environment to both students and instructors. It has been shown that the traditional face-to-face lecturing approach falls short of achieving the desired level of performance [1-3]. A hybrid course, or sometimes termed blended course, is a method of mixing the online and face-to-face teaching styles within one course and has been shown, in some cases, to be more effective [4-5]. Hybrid teaching allows for a style that isn't just "one size fits all." Online courses offer perhaps some of the greatest flexibility both with time, in terms of when a student views the content, and learning styles. If done correctly, the instructor can capture multiple learning style dimensions such as sensory versus intuitive, inductive versus deductive and visual versus verbal that will satisfy all students in the class. With online classes typically having high numbers of enrollment there is a good chance that there will be many different learning styles.

Massive Open Online Courses (MOOCs) are becoming more and more popular. These MOOCs are being offered at a reduced rate or in some cases at no cost. As a result, many universities are implementing greater numbers of online courses to keep up with society's demands and also increase or maintain enrollment numbers. Research has shown that there are many benefits and

advantages to taking online courses. There is greater flexibility in one's schedule which is great for those that are currently employed and/or have a family. If the student is on travel or not close to the university it also make it easier. The learning environment for some is more comfortable as well since one can stay home to take the class instead of coming to campus [6]. Roblyer [7] studied student motives for taking online courses and found that timing and pace of the course was of significant importance. In fact, having the ability to control the pace of the lectures and the time in which one reviews the lesson material was more important than having face-to-face interaction with the instructor. However, this research also found that students who have issues with time management are more likely to be frustrated and not enjoy the distance learning experience, resulting in them dropping the course. Scherrer et al [8] found that students like the convenience of taking less notes in an online class, this was particular useful for qualitative courses where the notes are more text based compared to a quantitative course where there are more equations and numbers. One of the main issues students had with distance learning was that some instructors did not always respond in a timely manner. From this research and others it is clear that online education is here to stay and to be a successful instructor it is important to minimize the frustration of students enrolled in the class and create an environment that is highly conducive to learning.

Engineering students are encouraged to pursue their professional engineering license within a few years of graduating with their undergraduate degree. One of the first steps in this process is to take and pass the Fundamentals of Engineering (FE) exam. The FE exam measures a student's understanding of key engineering concepts. Many schools require or highly recommend seniors take this exam prior to graduating. According to Sykes [9], very few universities actively help students prepare for this exam. The universities that do help students provide either face-to-face review or online review for review in all or select content areas of the exam. There are also companies that offer online and face-to-face reviews at a cost and in some cases even guarantee the examinee will pass or they can retake the review classes for free. No matter the method of review, the goal of the faculty should be to assist students in any way possible in helping prepare and pass the FE exam.

This paper discusses the transition from a face-to-face to a required online FE review course for seniors at The University of Texas at Tyler (UT Tyler). Data from multiple civil engineering graduating classes will be presented to show if there is a negative consequence of this transition. The yearly pass rate will be compared for three years prior to the transition and two years after. Based on the limited data available at this time there does not appear to be a negative impact on the students' performance on the exam.

Change in FE Exam Format

The format of the FE exam changed in January 2014 when the exam went from a pencil-and-paper exam to a computer-based test (CBT). Modifications to the exam format were also made. The previous exam was formatted in two sections that contained a total of 160 questions in 2- four hour blocks. The morning section was a general engineering exam with topics spanning many different areas of engineering, math and science. An examinee then had the ability to take any afternoon section that he or she wanted with questions specific to a particular engineering content area or take a second general engineering exam. Each person was provided with an equation book and

required to bring in an approved calculator. The exam was offered twice a year on a set day in April and October.

The new CBT contains 120 questions and is 6 total hours. The exam is completely done on a computer with the reference manual provided in an electronic format. A calculator is also provided on the computer for those needing it, although they are still allowed to bring their own approved calculator to the exam. Another significant change is that exams are tailored to each individual engineering discipline. This means that there is no longer a general civil engineering exam in the morning that is the same for all engineers. Each examinee must also take the exam in which they have or will receive their degree in. In other words, civil engineers must take the civil engineering exam and mechanical engineers must take the mechanical engineering specific exam. No longer can a student choose to take a general engineering exam unless that examinee's degree is, or will be, in an area that has no specific exam. The content of the exam has also changed for each discipline. For example, those taking the civil engineering exam no longer have sections in chemistry, thermodynamics or electrical circuits and certain topics within the other content areas have been removed. Lastly, there is greater flexibility as to when a person can take the exam. No longer is it offered only twice a year. Instead, the exam is offered 8 months of the year any day of the month. Overall, much has changed in the format and method of taking the exam. For the better or worse will only be determined over time.

Change in the FE Review at UT Tyler

UT Tyler offers engineering degrees in Civil Engineering, Mechanical Engineering and Electrical Engineering. Students within each department are required to take the FE exam in order to graduate with their Bachelor of Science degree within their respective major. Mechanical Engineering students are required to pass the exam to graduate and is one of only a few programs in the nation with this requirement. As such, all students have been provided with an opportunity for FE review sessions within their various disciplines.

Prior to the fall 2014 semester, review sessions were held in a face-to-face format. The general engineering topics were covered within ENGR 4109: Senior Seminar during the fall semester. Students would meet twice a week for one hour. One lecture for that week would be dedicated to the course material and the second would be review time for the FE. Faculty within the engineering departments would conduct the review. Content areas specific to the different engineering disciplines were covered outside of class during a time conducive for all students within the department. Faculty with expertise in a particular content area would lead the review sessions.

Beginning in the fall 2014, a separate zero credit course ENGR 4009: FE Exam Preparation was created. This became an online class where the content for each area for all three engineering disciplines are posted on Blackboard for students to access at their convenience. The content may include notes, worked example problems, PowerPoint slides and/or review videos. Review sessions are no longer face-to-face. In addition, three problem sets are assigned for each engineering discipline that students must submit prior at the end of the semester. Furthermore, they are also required to submit their FE registration by the end of the semester to receive credit in the course. All seniors are required to enroll in this course and receive credit in order to graduate.

Results

As a requirement of graduation, each student within the College of Engineering is required to take, or in the case of mechanical engineering students pass, the FE exam. The civil engineering department tracks how each student does on the exam. The following data represents civil engineering students only. The data analyzes three years prior to the change in both the FE review format as well as the testing format (pencil-and-paper to CBT) and two years after. Figure 1 shows the passing rate over the 5 year span of 2011-2015. The data shows the pass rate based on just the first attempt and the overall pass rate for the year (which includes those that took the exam again during that cycle and passed). The total pass rate data indicates that the transition from the pencil-and-paper exam to CBT nor the change in FE review style format has significantly affected the exam performance. It is noticed that in the fall of 2015, the 1st time pass rate is shown to be roughly 63%. However, it should be noted that only 62% of the senior class has taken the exam at that point so data is not yet available for the entire class. The total pass rate for 2015-2016 will not be available until the completion of the academic year which is after the publishing of this paper. The 2014-2015 senior class has shown to have the best total pass rate among the remaining classes. This might suggest that providing FE review material completely online is still beneficial for our students. It should also be noted that historically the national annual pass rate among all FE Exam disciplines is 73% [9]. UT Tyler is showing to be above this average in all but one of the four years where total pass rate data is presented.

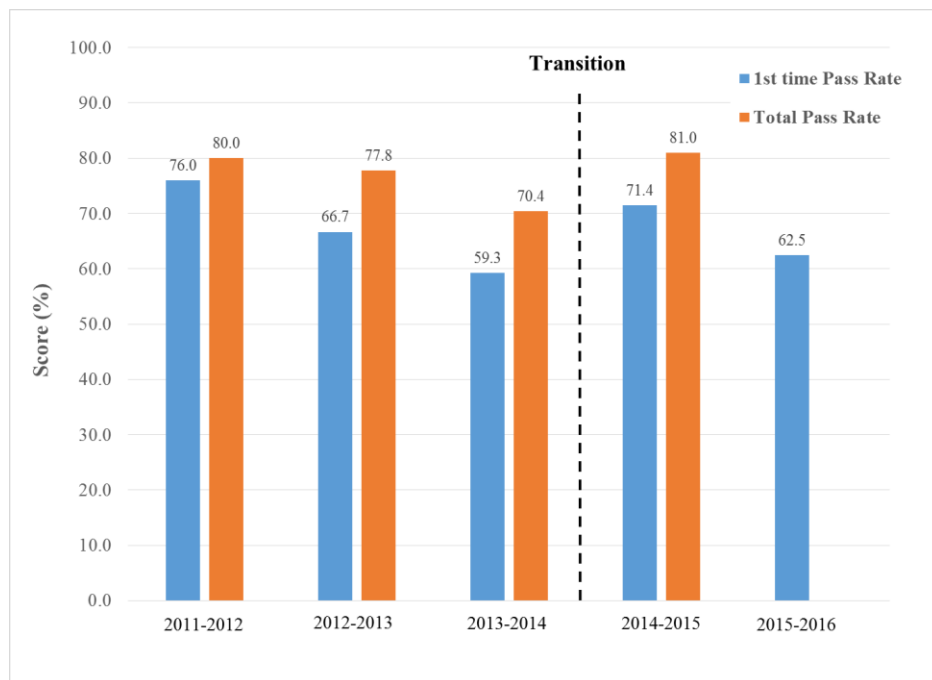


Fig. 1. FE Exam pass rates for Civil Engineering students at UT Tyler

Additional analysis is performed in Table 1 which compares the class GPA to the total pass rate for that academic year. There is no perfect correlation between these two parameters. However,

the 2014-2015 class does show to have the highest graduating GPA at a 3.27 and the highest total pass rate of 81%. The 2013-2014 class had the lowest total pass rate but the 2nd highest class GPA. Lastly, the data is also compared to the Gateway Exam results. The Gateway Exam was developed within the civil engineering department as a test students take during the spring of their junior year. The test examines many of the areas covered on the FE exam. There are a total of ten content areas with 10 FE style multiple choice questions per area and students have 3 hours to complete the test. Typically students do not put the effort into preparing for the Gateway Exam like they do for the FE exam so the scores are typically not very high. Nonetheless, based on the results the faculty determine an acceptable passing score for each section of the test. If a student does not meet that result then they are assigned homework problems during the summer from the section(s) they fail. The assignments are due when they return in the fall and must be submitted to remain registered for senior design. With the exception of the 2014-2015 senior class the previous three classes appear to show that the higher the overall Gateway Exam average the higher the total pass rate. Overall, it appears, from the small data set presented, the transition from a face-to-face review to providing review content online has had no negative impact on our students. It will be important to collect additional data as years go on to see if this statement remains true.

Table 1. Student success rates for the FE exam compared to class GPA and Gateway exam results

		Total Pass Rate (%)	GPA	Gateway Exam (%)
Face-to-Face	2011-2012	80.0	3.16	67.7
	2012-2013	77.8	3.07	61
	2013-2014	70.4	3.16	59
ONLINE	2014-2015	81.0	3.27	49.1
	2015-2016	62.5	3.14	50.7

Conclusions

This paper discusses the effects of transitioning from a face-to-face FE review to a completely virtual platform. Prior to 2014, students were provided with a review in a classroom setting with engineering faculty members leading the review. Currently, a required zero credit hour course has been created for students to enroll and access the review material online. To receive credit for this course the student must submit 3 problem sets within their particular engineering discipline and register to take the FE exam. The results indicate that there does not appear to be a negative effect on transitioning from a face-to-face review to online only. This statement can only be made however with the limited data provided. It will only be when more data become available that the impact of this transition will be truly known. Until then, the College of Engineering continues with the required online FE review course and look to further improve ways in which the material is delivered to students in the online format.

References

- [1] Borg, M. O., & Shapiro, S. L., "Personality type and student performance in principles of economics", *Journal of Economic Education*, **27**(1), 3-25, (1996).
- [2] Ziegert, A. L., "The role of personality temperament and student learning in principles of economics: further evidence", *Journal of Economic Education*, **31**(4), 307-332, (2000).
- [3] He, W., Gajski, D., Farkas, G., Warschauer, M., "Implementing flexible hybrid instruction in an electrical engineering course: The best of three worlds?", *Computers and Education*, **81**(2015), 59-68, (2015).
- [4] Means, B., Toyama, Y., Murphy, R., Bakia, M., and Jones, K., "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies", U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, Washington, DC, (2010).
- [5] Igu, A.K. and Jahren, C., "Evaluation of Hybrid Course Implementation in Construction Engineering", *ASEE North Midwest Section Conference*, Iowa City, IA, October, (2014).
- [6] Staff writer, "10 Advantages to Taking Online Classes," Open Education Database (OEDb), Online, Available at: <http://oedb.org/ilibrarian/10-advantages-to-taking-online-classes/>, (2012).
- [7] Roblyer, M.D., "Is Choice Important in Distance Learning? A Study of Student Motives for Taking Internet-Based Courses at a High School and Community College Level," *Research in Computing in Education*, **32**(1), 157-171, (1999).
- [8] Scherrer, C., Butler, R., Burns, S., "Student Perceptions of Online Education," *Advances in Engineering Education*, **2**(2), 1-23, (2010).
- [9] Sykes, J.A., "Exam Prep Done Right," *ASEE Prism Magazine*, March (2009).

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