Impact of Formal FE Review Course on Student Pass Rates in a Mechanical Engineering Program

Dr. Jared T. Fulcher, University of Evansville

Jared Fulcher is an Associate Professor of Mechanical Engineering at the University of Evansville.

Dr. Jessica Lofton, University of Evansville

Jessica Lofton is an Associate Professor of Mechanical Engineering at the University of Evansville and the Program Director for Mechanical Engineering.

Impact of Formal FE Review Course on Student Pass Rates in a Mechanical Engineering Program

Abstract

This paper evaluates the impact of a formal Fundamentals of Engineering (FE) exam review course on pass rates for undergraduate mechanical engineering students taking either the FE-Other Disciplines or FE-Mechanical exam. Completing the FE Exam is a graduation requirement for the mechanical engineering program in this study. Prior to the Spring 2020 semester a formal FE exam review course was offered by faculty. The course consisted of weekly in-person review sessions focusing on individual exam topics, which included concept reviews and solving practice FE problems. During Spring 2020, the review course moved to a virtual environment due to COVID-19, and it was cancelled the following year. Beginning Spring 2022, NCEES practice exams were made available for students to independently review. Pass rates were examined to evaluate the impact of removing the formal review course. Results indicate an in-person FE review course does not have a significant impact on student pass rates. An improvement in pass rate from the limited data set indicates access to NCEES practice exams may be an effective alternative to faculty-led FE review courses. Additional data will be collected to further study this trend.

Introduction and Background

The Fundamental of Engineering (FE) exam is a nationally standardized computer-based test (CBT) that engineering students take near graduation or after graduation to begin the process to become a licensed engineer. Students can take the exam year-round at NCEES-approved Pearson VUE test centers. There are seven discipline specific exams and a FE-Other Disciplines exam. Each version of the exam covers 14 topic areas from the respective disciplines [1].

At the University of Evansville (UE) mechanical engineering students are required to take the FE exam as a part of their senior capstone course. Students do not have to pass the FE exam to receive credit in the senior capstone course. This requirement was developed through discussion between the mechanical engineering faculty and the mechanical engineering advisory committee for the UE mechanical engineering program. With the program requiring students to take the FE exam some form of a review course has been offered for the last two decades, until it was cancelled in 2020.

Prior to cancelling the review course, the traditional format of the review course was an in-person faculty led review course offered to all engineering students, as well as members of the community, preparing to take the FE exam. The review sessions were topic specific and incorporated review material and practice exam material developed by faculty. The review course would span both fall and spring semesters with the aim of students taking the exam in late spring prior to graduation. Mechanical engineering students attended ten sessions over the course of the year. Most of the sessions were in the fall semester with the final few sessions taking place in January to allow students to be prepared to take the FE exam during the spring semester.

For the offering in Fall 2019 and Spring 2020 the final sessions of the review course were moved to a virtual environment due to COVID-19. The review sessions continued to be delivered synchronously by faculty to complete the Spring 2020 offering. The review course was cancelled the following academic year and has not been offered since. In Spring 2022, NCEES practice exams were made available for students to independently review. A timeline of events is shown in Figure 1. This study examines the impact of cancelling the formal in-person review and the impact of replacing it with NCEES review materials for independent student review.

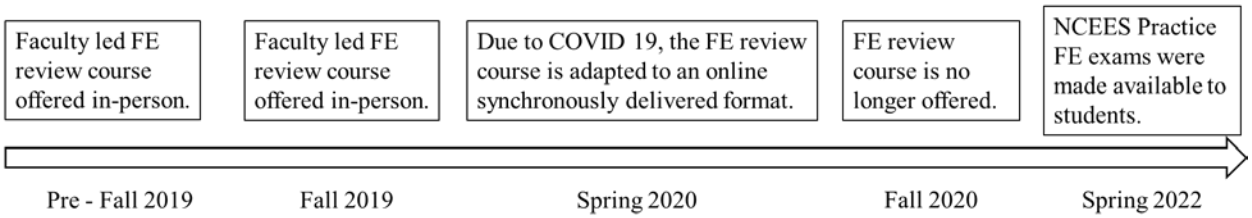

Figure 1. Timeline of FE review course offering.

Literature Review

Numerous papers have been written about methodologies for preparing engineering students to take the FE exam. Many institutions offer formal review courses that have modules covering specific exam topics. Along with formal review courses, it is common to have faculty incorporate FE exam style problems into various courses. Further, some institutions have students take FE style exams as a preparation strategy [2] [3]. Kiriazes and Zerbe benchmarked 50 civil and environmental engineering programs and found that 42% had a review course or review sessions available for students. A further 38% of the programs had review materials available for students.

When examining the effectiveness of these preparation strategies, it was found by several studies that motivation played an important role in student success on the FE Exam. Work was also done to determine the impact of providing information about the importance of passing the FE exam as a student matriculate [3] [4] [5]. Kiriazes and Zerbe found that 64% of general engineering programs discuss the FE process and 76% of programs benchmarked had licensure as part of the program objectives [3]. Swenty et al. studied the perceived confidence and performance of students preparing to take the FE exam. The study involves students completing FE style questions while taking a FE review course. It was found that students had an increase in confidence after taking the FE review courses, but a correlation between the confidence and performance was not distinguished [4]. These studies showed that the reinforcing of FE topics helps build student confidence and can have a positive effect on student performance.

Other works have been done to examine the importance of modifying the FE exam preparation methodologies to align them with current technologies and the incoming generation of students. The FE exam became a computer-based test in January 2014. The CBT FE exam is offered year-round at various testing centers [1]. Students can take the FE exam more frequently and on their own timeline, which may not align with the timing of formal in-person review courses. Another factor influencing the adoption of new methods of preparing students for the FE exam is aligning

the review process with Generation Z learners. Generation Z has grown up with technology and has seen technology integrated into many aspects of life. Cilliers found that students are connected throughout the day, which leads to wanting information quickly and according to their own schedule. It was also found that Gen Z students want more online based study materials [6].

Many programs have begun to adapt Gen Z learning strategies to how they approach preparing students for the FE exam [7] [8]. Crepeau et al. presented the development of an online based FE review course. The faculty developed 5–7-minute videos that covered various FE topics. Further engagement activities were developed to keep students' interest as they review for the FE exam. After implementing this online style review process, they saw an increase in student performance [7]. Beyond online review courses, programs have begun to offer self-led review options for students [9] [10]. Xing et al. built upon the online review course discussed by Crepeau et al. by introducing self-led elements. The elements included the 5–7-minute videos previously discussed and introduced recordings of question and answer sessions with faculty and FE style problem sets for additional assessment. They found that student confidence and performance increased upon adopting the online self-led review model [10].

Objective

Upon reviewing the current literature, the need to modify and adapt how programs provide review material for the FE exam is evident. Most of the work reviewed was based in civil and environmental engineering programs. One study was based in chemical engineering and two were based on modifications done by a single mechanical engineering program. The current study looks to evaluate the impact of changing the FE review process for mechanical engineering students taking the FE – Other Disciplines exam. As discussed previously, a formal in-person review course with 10 specific sessions was offered to students in the past. Currently NCEES practice exams are available for students to check out and review on an independent basis.

This study aims to answer the following research question:

- Did removing the in-person FE review course have an impact on student pass rates for the Other Disciplines and Mechanical FE Exams?

Results

Past assessment data revealed that students in the mechanical engineering program at UE perform better on the Other Disciplines exam, which is well-suited to a broad curriculum. The pass rates for students from UE taking the Other Disciplines and Mechanical FE Exams since 2016 are shown in Figure 2. While students are consistently directed to register for the Other Disciplines exam, the data show not all students follow this advice from faculty, with pass rates for students taking the Mechanical FE Exam frequently being 0%.

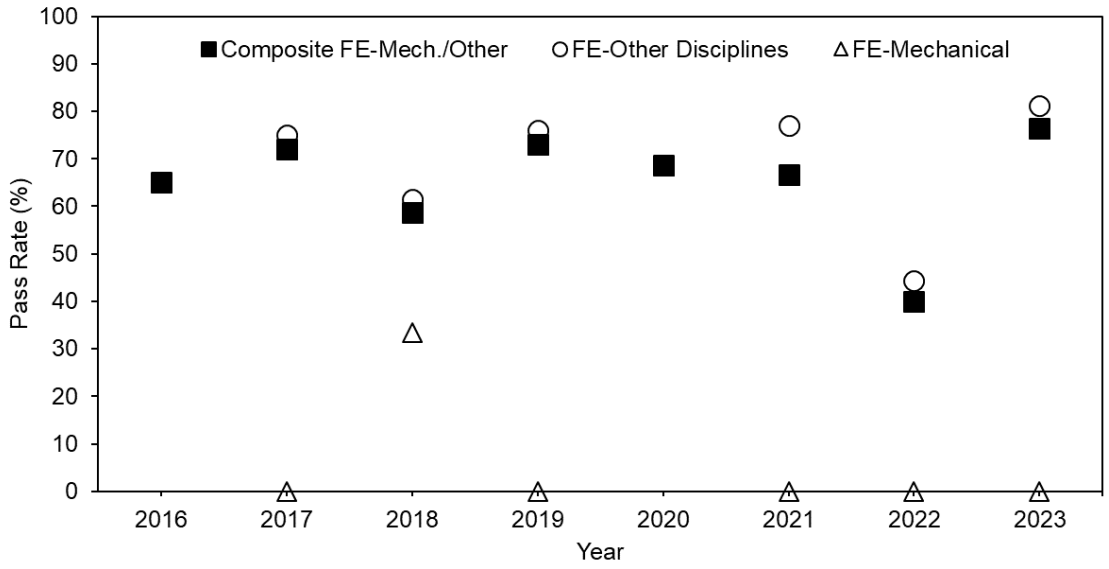

Figure 2: FE Pass Rate

Factors such as student motivation, grade point average, and changes in instructors were not accounted for. The number of students taking the FE exam is listed by year in Table 1.

Table 1: Student Sample Size

Year	FE - Other Disciplines	FE - Mechanical	Composite - FE Mech./Other
2016	20	0	20
2017	24	1	25
2018	26	3	29
2019	25	1	26
2020	16	0	16
2021	13	2	15
2022	18	2	20
2023	16	1	17

While there is a slight decline in overall pass rates for 2020 and 2021, the decline is not statistically significant. The overall pass rates in 2020 and 2021 fall within the range of the pre-pandemic years during which an in-person review course was offered. Students were forced into virtual learning formats in early March 2020, which included both regular coursework and the FE review course. No FE review course was offered to students taking the exam in 2021, and many mechanical engineering courses were still being taught remotely. However, the overall pass rate for 2020 and 2021 is within the range of the pre-pandemic years during which an in-person review course was offered. The 2021 pass rates suggest that an FE review course does not have a significant impact on student performance.

Focusing only on the Composite – FE Mech./Other results, a more significant drop in overall pass rates is evident in 2022. The overall pass rate of 40% in 2022 is a mild outlier in the data set. The

mild and extreme outlier regions are indicated on Figure 2, where the shaded region represents non-outliers. Statistical outliers were determined using definitions based on the fourth spread of the data. No extreme outliers were present.

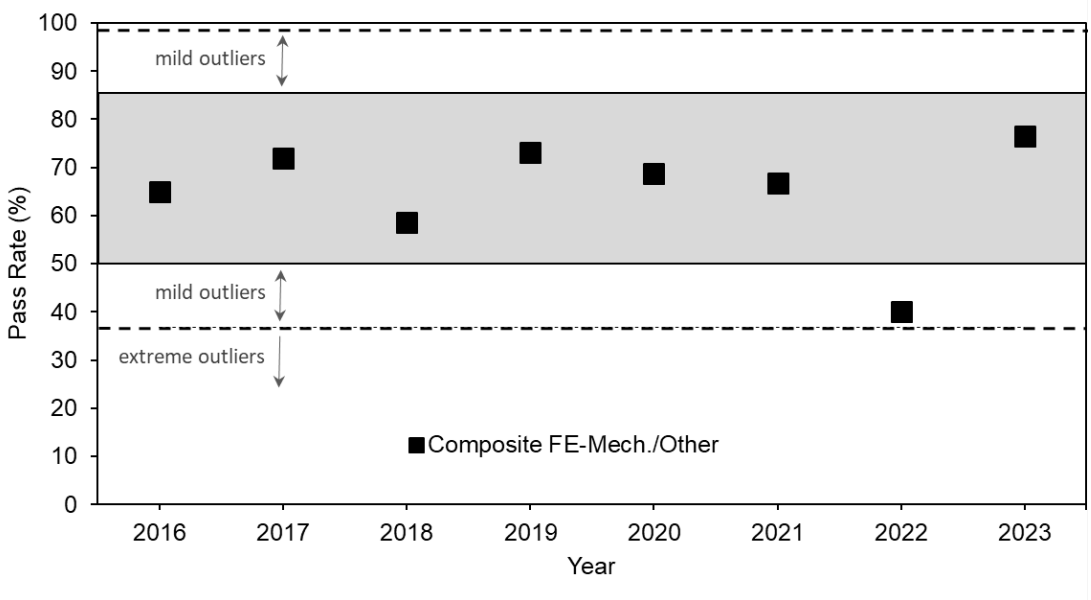

Figure 3: Outlier Regions

Students in the 2022 cohort were in their sophomore year when courses transitioned to online learning, and many of their core and upper-level mechanical engineering courses were offered in online or hybrid formats. Physical copies of NCEES practice exams were made available for independent student review after January 2022.

The highest pass rates occurred in 2023. No FE review course was offered, but NCEES practice exams were available for independent student review throughout the year. Most core and upper-level mechanical engineering courses had returned to in-person instruction for this cohort. More data area needed, but this single observation suggests that access to practice exams has a higher impact on student performance than an FE review course when comparing to pre-pandemic years.

Conclusions

Based on the data, an in-person FE review course does not have a significant impact on student pass rates in the Other Disciplines or Mechanical Engineering FE exams. The data suggest that access to NCEES practice exams has a stronger impact on student performance and improves student pass rates. Additional data will be collected on student pass rates and student use of the NCEES practice exams.

Thet results in this study are limited to a single institution. It is difficult to separate the individual impacts of the pandemic, changing course delivery methods, and the discontinuation of the FE review course on student pass rates. Although the literature review suggested that student motivation plays an important role on student success in the FE Exam, no data were available

related to student motivation in this study examining historical pass rates, Students were not required to pass the exam to meet a course or degree requirement. The reported pass rates were also for small cohorts, and demographic data were not included. Future work could explore student pass rates and the use of the NCEES practice exams across different demographic groups.

References

[1] NCEES, "Fundamentals of Engineering (FE) Exam," Engenius, 2024. [Online]. Available: https://ncees.org/exams/fe-exam/. [Accessed 6 February 2024].

[2] E. Koehn and R. D. Malani, "Review for and Assessment of the Fundamentals of Engineering Exam," in *ASEE Annual Conference and Exposition*, Portland, OR, 2005.

[3] R. E. Kiriazes and E. Zerbe, "Department Policy and Programs that Support NCEES FE Exam Prep in Civil and Enviromental Engineering," in *ASEE Annual Conference*, Minneapolis, MN, 2022.

[4] M. K. Swenty, C. R. Shearer, B. Z. Dymond and W. I. A. Idewu, "Does a Review Course Increase FE Exam Preparedness?," in *ASEE Annual Conferernce*, Virtual Meeting, 2021.

[5] S. J. Khatib, R. Taraban and W. D. Lawson, "Changes in Student Confindence, Strategies, and Reflection in a FE Review Course in Chemical Engineering," in *ASEE Gulf-Southwest Annual Conference*, Albuquerque, NM, 2020.

[6] J. Crepeau, B. Willis, S. Quallen, S. W. Beyerlein, D. Cordon, T. Soule, P. Northcutt, T. A. Gaffney, J. Kimberling, A. C. Shears and A. Miller, "Generation-Z Learning Approaches to Improve Performance in the Fundamentals of Engineering Exam," in *ASEE Virtual Annual Conference Content Access*, Virtual Online, 2020.

[7] E. J. Cilliers, "The Challenge of Teaching Generation Z," *International Journal of Social Sciences,* vol. 3, no. 1, pp. 188-198, 2017.

[8] R. R. Foltz, T. W. Mays and K. C. Bower, "Adding Student Led Components to FE Review Courses to Improve FE Examination Scores at the Citadel: A Case Study," in *ASEE Southeast Section Conference*, Chattanooga, TN, 2005.

[9] S. M. Quallen, J. Crepeau, B. Willis, S. W. Beyerlein and J. Peterson, "Transforming Inductory Engineering Courses to Match Gen Z Learning Styles," in *ASEE Annual Conference*, Virtual Meeting, 2021.

[10] T. Xing, S. W. Beyerlein and J. Crepeau, "Impact of Self-Directed Learning Modules on Preparing Students to Take the FE Exam," in *ASEE Annual Conference and Exposition*, Baltimore, MD, 2023.