

Case Study: Reflection of FE and PE exam student preparation strategies for engineering faculty and administrators

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Introduction

Passing the Fundamentals of Engineering (FE) and Principles and Practice of Engineering (PE) exams are requirements in the typical pathway for individuals to become licensed professional engineers. Both exams are administered by the National Council of Examiners for Engineering and Surveying (NCEES). The NCEES makes available exam specifications [1-2] and review manuals [3-4] which describe what subjects and associated topics may be related to questions on the exams. It is recommended to take the FE exam within one year of graduation from an engineering degree program [1]. The PE exam includes more discipline-focused questions and can be taken at varying stages (depending on the state requirements) after passing the FE exam [2].

The NCEES provides university representatives with access to the FE and PE exam biannual results for first-time takers (i.e., Subject Matter Reports or SMRs). A range of statistical results for each institution major, examination type, and ABET Inc. accredited programs are provided for each exam subject and overall [5]. The FE and PE Civil exams are more frequently taken when compared to other exam types [6]. This could be due to professional engineering licensure being more of a requirement for civil engineering positions than in other disciplines. Therefore, undergraduate civil engineering programs should have an interest in encouraging their students to pass these exams.

This paper highlights ways for faculty and administrators to encourage students in pursuing professional licensure by enhancing student and alumni performance on the FE Civil and PE Civil exams. The primary purpose of the paper is to describe the implementation of a number of measures that resulted in improvements on FE and PE performance metrics, where related literature and substantive evidence were provided to strengthen the basis of the recommended measures. Most recommendations described in this paper were conceived from a reflection of measures that were contemplated, implemented or observed during the author's 10+ years of teaching experience in civil and environmental engineering degree programs. Many of these recommendations can be applied in other engineering disciplines and/or have also been reported by others [7]. The author implemented several of these measures in Civil Engineering program courses at Mississippi State University (MSU) over the last four years (Fall 2021 to Spring 2025 semesters). In comparison with the previous four-year period, there was an 8% and 24% increase in the number of passers for the FE and PE exams, respectively.

Scheduled Class Lectures:

Student interest in taking the FE and PE exams can increase by having a class lecture on the matter. The lecture should discuss the value of being licensed, describe the typical pathway undergraduates can take to pursue licensure, and discuss how an undergraduate civil engineering degree program best prepares students to pass the FE Civil exam, even if the student wants to be an environmental engineer. The lecture should also describe how unlicensed graduates pursue successful careers as not all students are interested in being a professional engineer. Over the last four-year period at MSU, passing the FE Civil exam was changed from a required to a bonus course assignment which likely resulted in a 3% decrease in the number of FE exam takers.

The speaker type and classification level at which the lecture(s) are delivered should be considered. Performing the lecture only during the graduation semester may not be ideal because this is during the optimal time range to prepare for or take the FE exam. Over the last four years, the passing rate decreased by 24% for MSU Civil Major affiliates (MCMAs) who waited more than one year after graduation to take the FE exam. If the lecture is delivered to freshman students, then faculty can describe to the students how the FE exam includes questions that are related to many courses in their degree program before they take these courses [7]. The speaker for the lecture could be faculty, a state board of engineering licensure representative, or a consultant. If a licensure board representative is selected, then the audience can include all students in the college of engineering. A consultant could be an ideal speaker if their position requires them to be licensed.

Reminders and Encouragement:

Consistent reminders about pursuing licensure could motivate students to prepare for the FE exam during their academic studies. In the author's opinion, a portion of the first-class lecture of every course is full of inefficiencies and can be replaced with a discussion on licensure. Immediately after introducing themselves to the class, the instructor can ask the students what the meaning is of the "P.E." credential listed next to their last name. An open discussion related to licensure can follow. During the discussion, the instructor can remind students of the importance of learning the material in the course they are currently taking by associating the course topics shown in the syllabus with the FE/PE exam topics in the exam specifications [1-2]. For example, if a student wants to be a professional engineer who practices structural engineering, then the instructor should tell the student they need to learn concepts (e.g., flow measurement) in the fluid mechanics course to pass the FE exam. For the remaining lectures, the instructor can notify the students when a topic covered in class could be associated with a question on the FE or PE exams. Through this emphasis, students may be more motivated to learn the topic.

Strategies for encouraging students to pursue licensure include: (1) incorporating an entire course focusing on the exams and/or licensure into the curriculum, where positive outcomes have been reported [8]; (2) incorporating some of the required steps to obtain or maintain licensure in a course assignment. The National Society of Professional Engineers currently offers free student membership with access to professional development hours (PDHs); (3) asking students to complete a survey about the FE or PE exam, where the survey is indirectly used as a communication tool to encourage students to take the exams; and (4) having faculty make an announcement to the undergraduate class stating the name of the student who passed the FE exam and where encouraging words for the student to pursue professional licensure can be mentioned. Some students may even plan to pass the FE exam just to receive the recognition.

Updating Course Examinations:

Three ways to format course exams that are more aligned with the FE or PE exams are to have the same time requirement, have answers that are only correct or incorrect, and allow students to use the FE Reference Handbook (FERH) during exams [3], [9]. Examinees for the FE (assuming 320-minute exam time) and PE exam have 2.9 and 6.0 minutes, respectively, to answer each question [6]. For 50-minute and 75-minute course exams based on FE exam time requirements, the number of questions per course exam are 17.2 and 25.8, respectively. Seniors or recent graduates primarily take the FE exam, and many FE exam subjects are related to courses below the senior level (e.g., mathematics, statics). To adjust for experience level in a junior-level

course, slightly less than 17 questions on a 50-minute exam would be reasonable. In addition, a learning curve may be needed for students to be more comfortable with exams that only have correct or incorrect answers, where at least one course in the degree program should have exams formatted this way. Student confidence was reported to increase in taking the FE exam by students who previously took course exams with the FERH [9]. The author of this case study asks students to make their own exam study sheet, which is primarily used as an ungraded learning activity where limited or no faculty resources are used.

Faculty determine the level of exam difficulty in their courses which could eventually affect student performance on the FE/PE exams, but faculty may hesitate to raise the standard. If an instructor assigns a 50-minute 7-question exam and observes most students completed the exam in 40 minutes, then that could imply most students will not complete a 50-minute 15-question exam. However, if faculty set a higher standard, then students may be more motivated in learning the course material because they are still held accountable [10]. Similar results may not occur if the exams are already too challenging. Faculty may also need to increase their own workload to improve student learning. If more questions are included in each exam in a course, then faculty will need to develop more exam questions and invest more time formatting/grading larger-sized exams. When standards are raised, multiple exam versions (i.e., make even more exam questions) may need to be developed to prevent academic dishonesty.

Updating Course Content:

The exam specifications and review manuals can be used by faculty to make updates on old course topics that are more aligned with topics on the FE [11] and PE exams [12] which may be more relevant to the current practice. For example, after initially reviewing the PE Reference Manual [4], and then subsequently taking PDHs on culverts and interacting with a practicing hydraulics engineer, the author modified the brief lecture topic on culvert analysis into a more detailed form in the Open Channel Hydraulics course. Afterwards, the book the author uses to teach Open Channel Hydraulics was updated to include detailed sections on culvert analysis. Notwithstanding, the topics on the FE and PE exams are non-exhaustive, but the topics listed under some subjects are numerous enough that more than one course may be needed to teach one subject (e.g., Geotechnical Engineering). Also, the curriculum in many degree programs may not cover all the exam subjects [11] and topics.

Faculty teaching courses related to an FE exam subject can cover content on other subjects to some extent within the same course. For example, a faculty member instructing a water resources engineering (subject) course can provide a detailed mathematical (subject) solution to in-class example problems that include a fully described application of fluid mechanics (subject) principles when solving the problem. Thus, three subjects are at least briefly reviewed in one course. In comparing the most recent with the previous four-year periods, the Mathematics & Statistics, Fluid Mechanics, and Water Resources and Environmental Engineering Subject Ratio Scores for MCMAs increased between 0.03 and 0.07. Moreover, civil program faculty were not assigned to teach mathematics or fluid mechanics courses during these periods.

To prepare students for the PE exam, efforts should be focused on updating senior- or graduate-level engineering courses to more align with PE exam subjects or topics [12]. Two example subjects in the Civil: Water Resources and Environmental (WRE) PE exam are Open Channel Hydraulics and Hydrology, both of which are existing courses in many civil engineering degree

programs. When students complete these courses, they are already acquiring some knowledge to pass the WRE PE exam. For example, the author covers most concepts depicted in the Open-Channel Flow Section of the PE Civil Reference Handbook [4] primarily in the senior-to-graduate-level Open Channel Hydraulics course and to a limited extent in the junior-level Water Resources Engineering course.

Faculty Collaboration:

The FE Exam includes questions from 14 subjects and multiple faculty members are needed to teach more than 14 courses to cover the subjects. The subjects and topics also change over time. For example, thermodynamics is no longer a subject [6]. The department's curriculum committee can periodically align the program curriculum with subjects listed in the FE Civil Exam Specifications, although ABET requirements should be reviewed while considering changes. All department faculty should also be made aware of the importance of the exams. For example, some faculty may be focused on research which typically does not require professional licensure. Faculty can also collaborate in developing mock exams. For example, MSU faculty in the areas of water resources and environmental, geotechnical and construction engineering developed a 1.5-hour time limit WRE PE exam team competition at the 2025 ASCE Gulf Coast Student Symposium. Also, as part of an ABET assessment activity, faculty collaborated to incorporate ethics-related assignments in three courses beginning in Spring 2024, where the Ethics & Professional Practice Subject Ratio Score was observed to increase by 0.05 over the next two SMRs (July 2024 to June 2025).

Assessing Performance:

Prior to interpreting the NCEES results, several issues should be considered related to differences in institution major taker characteristics, inaccurate reporting by exam takers [8], statistical analysis issues (e.g., sample size) [5], and differences in faculty instruction methods or engineering programs. To address some of these issues, the author recommends analyzing a dataset larger than one or two biannual dataset(s). For example, FE exam data from the last six years (July 2019 to June 2025) can be weighted (based on takers and passers) to represent the six-year performance results ending in Spring 2025, the six-year Fall 2024 performance results can represent the results from January 2019 to December 2024, etc. By doing so, long-term performance and trends can be more clearly identified. The results could also be used as ABET reaccreditation documentation every six years [13], comparing the recent with the prior six-year results. Data from 2020 should be considered as an outlier unless the first- and second-half period data from 2020 are incorporated into the same data set.

Based on NCEES PE exam reporting methodology (those who take the exam one year after graduation), there is a lag effect on the potential relationship between exam and undergraduate program performance. Assume a new faculty teaches a graduation semester course in Fall 2026. The earliest (except for the last half of December 2027) NCEES can report those who enrolled in the faculty's course and took the PE exam is the first SMR of 2028. To reduce the impact of the lag effect and ambiguity on when graduates take the PE exam, about a decade of SMR data should be analyzed. Notwithstanding, data (if available) from your state's board of engineering licensure can be used to identify graduates who recently passed the PE exam. The past three years of newsletters from the Mississippi Board of Licensure for Professional Engineers and Surveyors [14] indicate 3-13 MCMAs passed the PE exam in less than one year after graduation. Presumably, these results will not be incorporated into the SMRs. Moreover, 34 MCMAs were

found to have both graduated and passed the PE exam within the last four-year period. These results indicate undergraduate programs play a role in student preparation for the PE exam.

One method to consider in assessing PE exam performance is to calculate the percentage ratio of the total number of passers attributed to an institution major divided by the total number of ABET Comparator passers over the last “n” years. Then compare that value with the computed value from n to 2n years ago. For example, 4-8 years ago, 0.58% of individuals who passed the WRE PE exam on the first attempt were MCMAs; and 0-4 years ago, this value increased to 0.96%. These results indicate an increase in the share of WRE PE exam passers who are MCMAs which could demonstrate a successful program outcome. Possible reasons for the improvement could include a recent (i.e., 2-6 years ago) hire of a faculty who teaches courses in water resources and/or environmental engineering subject areas and/or a maturing degree program concentration in environmental (& water resources) engineering.

Conclusions:

A nonexclusive objective of engineering degree programs should be to facilitate the formation of professional engineers by encouraging students to pass the FE and PE exams. This involves increasing the quantity of takers who could benefit by passing the exams and improving student ability levels so those who take the exam can pass. To achieve this objective, faculty can organize lectures about the exams, collaborate with faculty, and make pedagogical, course or degree program modifications. The PE exam can now be taken at an earlier career stage and faculty can consider preparing students for this exam in some senior-level courses. Multiple years of exam results should be analyzed prior to justifying any change to a degree program. This paper contributes to the literature by providing additional suggestions to faculty and administrators on how they can improve student or alumni performance on the FE and PE exams.

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