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WIP: Increasing Encouragement and Support for Mechanical Engineering Students Taking the FE Exam

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Abstract

In this paper, a multi-year approach is outlined to increase awareness and encourage mechanical engineering students to pass the FE Exam in the senior year of their undergraduate studies. At the institution described in this paper, completing the FE Exam is a degree requirement for mechanical engineering majors. However, students are not required to earn a passing score, which may negatively impact student levels of motivation and preparedness. Institutional pass rates have historically fallen below the national average. In an effort to improve institutional pass rates, faculty have developed a plan to incorporate additional strategies to encourage and support undergraduate students to pass the FE Exam before graduating. The new programming will be embedded in all four years of undergraduate study. Programming includes external speakers, alumni feedback, and course-related discussions that highlight the potential benefits of passing the FE Exam as a student and pursuing a PE License after graduating. New strategies to increase motivation will be incorporated at the School, Program, and student organization levels. Additionally, new study tools and exam preparation materials will be developed and provided to students for self-guided review. Future work will include data collection and assessment to determine levels of student participation in and effectiveness of the multi-year approach outlined here.

Introduction and Background

Mechanical engineering students at the University of Evansville (UE) are required to take the Fundamentals of Engineering Exam (FE exam) as part of their senior capstone course. Students do not have to pass the FE exam to receive course credit. This requirement was established by the UE mechanical engineering faculty and the UE Mechanical Engineering Advisory Committee. However, the formal FE review course offered by the UE School of Engineering and Computer Science (SECS) was discontinued fall 2020 due to funding changes.

Formal review courses and/or sessions are a well-established strategy for FE exam preparation. Kiriazes and Zerbe benchmarked 50 civil and environmental engineering programs and found that 42% had a review course or review sessions available for students [1]. Newhouse et al presented a discussion a decade long development of a FE review course for a civil engineering program. In the study the authors documented how the course was modified during the time and how it correlated to sustained high pass rates [2]. 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 [3]. These studies showed that the reinforcing of FE topics helps build student confidence and can have a positive effect on student performance.

Further, many engineering programs have been adapting FE exam review methods to an online environment. This trend aligns with the understanding of how Generation Z learns. Cilliers found that students want information quickly and according to their own schedule. This leads to

Generation Z students wanting more online based study materials [4]. Another contributing factor is that the FE exam is purely computer based. This allows students to take the exam year-round and various locations [5]. Crepeau et al. developed an online based FE review course that incorporated faculty made videos and other materials. After implementation, an increase in student performance was seen [6]. Beyond online review courses, programs have begun to offer self-led review options for students. Xing et al. built upon the online review course discussed by Crepeau et al. by introducing self-led elements. These elements included recorded questions and answer sessions, and extra FE style problem sets. Student confidence and performance was seen to increase with the adoption of the additional elements [7].

Beginning in spring 2022, the UE SECS made NCEES review materials available to students for independent review. A 2024 study found that UE mechanical engineering student FE pass rates were not significantly impacted by the cancellation of the formal review course. The results of the 2024 study suggested that the availability of the independent review materials had a positive impact on FE pass rates [8]. These results agree with the current trend of modifying FE review resources to be more self-led and increased online availability.

Beyond the review materials discussed in the 2024 study, the mechanical engineering faculty have been developing and incorporating additional FE exam awareness and preparation strategies. Integration of the strategies into the mechanical engineering student experience is expected to increase awareness, preparation, and motivation for taking the FE exam. The current work focuses on the methods developed to help increase student awareness and preparation and their impact on FE exam pass rates for mechanical engineering students at UE.

Methods

FE Exam results are included in the assessment plan for the Mechanical Engineering program described in this study. Aggregated test scores are reviewed in key subject areas and compared with national averages. Overall pass rates are not assessed but are included in annual program reviews and discussed with members of the program's external advisory council. Although students in the program may score at, or above, the national average in individual subject areas, the pass rate consistently falls below the national average.

In an effort to improve institutional pass rates, faculty have developed a plan to incorporate additional strategies to encourage and support seniors in the Mechanical Engineering program to pass the FE Exam before graduating. The new programming will be embedded in all four years of undergraduate study. Programming includes external speakers, alumni feedback, and course-related discussions that highlight the potential benefits of passing the FE Exam as a student and pursuing a PE License after graduating.

The new strategies will be gradually introduced, and data will be collected each year to assess the impact on student performance and motivation. As a small program, the majority of students remain with their cohort when enrolling in required courses offered by the mechanical engineering faculty. This allows more targeted programming and simplifies the logistics for introducing new efforts and maintaining a level of uniformity across the cohort. The Mechanical Engineering program at UE also requires students to participate in a 4-year Integrated Design Sequence, where student teams participate in engineering design projects every Spring semester,

at a minimum. There is an associated Integrated Design course for each year of study. Additional project-based courses are required in the Fall semester for freshmen, as an introduction to mechanical engineering, and for seniors, as the first semester of a 2-semester senior design project.

Course embedded strategies for encouraging students to pass the FE Exam are summarized in Table 1. Phase 1 includes course elements that have existed prior to AY23-24, representing the baseline level of professional licensure discussion in required courses. Other required courses will be phasing in at least one quiz with FE-style questions for the subject area.

Table 1: Outline of FE Encouragement Plan embedded in courses.

Cohort	**Course-Level Strategies**
Freshmen	**Phase 1 (AY23-24) Baseline.** • *(Fall) ME 101*: Introduced to FE Exam and PE licensure • *(Spring) Integrated Design I:* Students further introduced to licensure and connections to career pathways
Sophomores	**Phase 2 (AY24-25)** • *(Spring) Dynamics:* Further describe licensure process and importance of familiarity with FE Reference Handbook. Add quiz assignment with FE-style questions from the subject area in the "Other Disciplines" exam **Phase 3 (AY25-26)** • *(Fall) Mechanics of Materials:* quiz with FE-style questions from the subject area in the "Other Disciplines" exam • *(Fall) Statics:* quiz with FE-style questions from the subject area in the "Other Disciplines" exam
Juniors	**Phase 2 (AY24-25)** • *(Spring) Fluid Mechanics:* quiz with FE-style questions from the subject area in the "Other Disciplines" exam **Phase 3 (AY25-26)** • *(Fall) Thermodynamics*: quiz assignment with FE-style questions from the subject area in the "Other Disciplines" exam • *(Fall) Materials Science Lab*: quiz assignment with FE-style questions from the subject area in the "Other Disciplines" exam **Phase 3 (AY25-26)** • *(Fall) Engineering Probability & Statistics:* quiz assignment with FE-style questions from the subject area in the "Other Disciplines" exam
Seniors	**Phase 1 (AY23-24) Baseline.** • *(Fall) Senior Design I:* FE and PE discussed in more detail, emphasis on lifelong learning • *(Spring) Senior Design II*: FE Exam attempt required **Phase 3 (AY25-26)** • *(Fall) Heat Transfer*: quiz assignment with FE-style questions from the subject area in the "Other Disciplines" exam

*Note: The courses/cohorts are listed based on the advertised plan of study. Some student schedules deviate from this plan.

Several instructors also refer to the FE Reference Handbook or allow pages from the FE Reference Handbook as a resource for exams, in required courses in the ME curriculum. One goal of incorporating the FE Reference Handbook in courses is to encourage students to familiarize themselves with the resource prior to registering for the FE Exam.

In some courses, “Professional Engagement” assignments are used by instructors to encourage students to attend guest speaker events, participate in career fairs, explore professional organizations, and engage with activities that promote professional development, engineering outreach, or personal growth. Providing extrinsically motivating factors like a low stake graded assignment helps increase student participation in optional programming when intrinsic motivation may not. Student engagement outside the classroom significantly declined following the outbreak of the COVID-19 pandemic. Student engagement levels within the SECS have been slow to recover; these conditions influence the creation of “Professional Engagement” assignments. Ideally, students would recognize the value of the programming and be inclined to participate without grades being attached. Further work will be done to understand and improve student motivation, as well as highlighting the added value resulting from student engagement.

As part of the multi-year approach to improving student pass rates on the FE Exam, new strategies to increase motivation will be incorporated at the School, Program, and student organization levels. Additionally, new study tools and exam preparation materials will be developed and provided to students for self-guided review.

Guest speakers at some events will be asked to include some discussion of the importance or impact of a PE license in their career. In sharing their story, many guest speakers will also encourage students to pass the FE Exam as a senior in college. In Phase 1 of this study, guest speakers have also encouraged students to attempt the PE exam soon after passing the FE Exam, which is allowed by the state licensure board. Hearing this encouragement from guest speakers, some of whom are Mechanical Engineering alumni, will hopefully motivate students to give their best effort when first taking the FE Exam as part of their graduation requirements.

The university’s Career Development Center hosts an engineering-focused career event each semester. The Spring event is a career forum with panel discussions led by employers (engineers, managers, & HR specialists). The significance of PE licensure is often mentioned as part of these panel discussions, but it is not a dedicated component of the event. Feedback varies depending on the industry and personal experience represented by the panelist; it gives students a broader view of career milestones, but it may not always motivate students to pass the FE Exam.

The Mechanical Engineering program has a dedicated site within Blackboard, the LMS adopted by the university. The site requires students to log in with their university credentials and access is limited to enrolled students majoring in mechanical engineering. Tutorials, program standards and templates, job postings, announcements, and more are shared with students via the site. There is a dedicated section with advice from alumni, including feedback related to the benefit of taking the FE Exam as a student. There is also a dedicated section with FE Exam resources. Currently, this section includes the FE Reference Handbook, NCEES links, and general information about the topic areas covered on the “Other Disciplines” exam.

In Phase 2, the FE Exam Resources on the Blackboard site will be expanded to include some practice problems for self-guided student review. Additional FE-style practice problems will be created and made available in the format of (un-graded) Blackboard quizzes for review in specific subject areas as part of Phase 3. Faculty teaching courses in these subject areas will be encouraged to direct students to the Blackboard site for additional practice. Phase 4 will include additional review materials, such as 1-page summary sheets for specific subject areas, posted on the program Blackboard site.

Phases 3 and 4 will include the implementation of new strategies to increase student intrinsic motivation to use the FE Exam resources available to them and to pass the FE exam on their first attempt. Additional research, planning, and development of these strategies will occur in Phase 2. Optional programming planned to be available for students is summarized in Table 2 and grouped by academic year. Once introduced, most strategies are planned to be sustained as continuous offerings for future cohorts. Guest speaker availability may vary from year to year.

Table 2: Optional Programming Available to Students (New Additions)

	Programming	**Host Organization**	**Notes**
Phase 1 (AY23-24)	ASME Guest Speakers – two meetings emphasizing FE and PE license	Student organization event	• No seniors attended these events; some freshmen attended each event • ***Goal:*** at least one guest speaker event per semester that promotes licensure
	NSPE Guest Speakers for E-Week	School-level event (lunch included)	
	ASHRAE Guest Speaker on Ethics & Statutes, PDH earned for PE's	Local professional organization event hosted on campus by ME Program	
	Welcome/Orientation meeting for new ME students – discussion of FE graduation requirement and professional licensure	ME Program	• ***Continuous offering***
	ME Newsletter – various alumni spotlights highlighting new and existing PE's	ME Program, monthly newsletter	• All students receive the electronic newsletter • ***Continuous offering***
	FE Practice Exam (physical copy) available for seniors to reserve from Associate Dean's office	School-level support	• All seniors may borrow practice materials • ***Continuous offering***
Phase 2 (AY24-25)	NCEES new interactive online practice FE Exam available, advertised to students	NCEES, available for student purchase	• ***Continuous offering ($)***
	FE practice problems available on internal ME Program LMS page	ME Program, available beginning Spring 2025, requires university log-in	• ***Continuous offering***
	Planning for intrinsic motivation strategies	ME Program	*Work in Progress*
Phase 3 (AY25-26)	Subject-based practice quizzes available on internal ME Program LMS page	ME Program, available beginning Fall 2025, requires university log-in	• ***Continuous offering***
	ASHRAE Guest Speaker on Ethics & Statutes, PDH credits earned for PE's	Local professional organization event hosted on campus by ME Program	• Planned bi-annual offering, meets IN PE requirements
	Feedback and tips from recent students listed on internal ME Program LMS page	ME Program, available beginning Fall 2025, requires university log-in	• ***Continuous offering***
	New motivational strategies, part 1	ME Program	*Work in Progress*
Phase 4 (AY26-27)	Subject-based summary sheets and review material available	ME Program, available beginning Fall 2025, requires university log-in	• ***Continuous offering***
	New motivational strategies, part 2	ME Program	*Work in Progress*

Results and Discussion

Planned Assessment

To assess the effectiveness of the programming outlined in this paper, FE Exam data will be tracked, and student surveys will be collected. By executing new programming in a phased strategy, each subsequent cohort will have had more FE-focused interventions than the previous cohort. Student surveys will be used to evaluate student participation in activities and use of FE Exam resources. The surveys will include questions about student motivation to pass the FE Exam, perception of significance of licensure, and intent to pursue PE licensure in the future. Trends in student responses will be identified and compared with exam pass rates.

Conclusions and Future Work

This paper outlines a plan for introducing additional scaffolding and encouragement for students in a Mechanical Engineering program where attempting the FE Exam is a graduation requirement. Passing the FE Exam is not required and pass rates have been lower than the national average. The initial phases of this multi-year approach to improve pass rates include providing additional practice materials and opportunities for self-guided study. FE-style questions will also be introduced in more course assignments. Feedback from guest speakers and alumni will expose students to various perspectives on the significance of PE licensure and the benefits of passing the FE Exam before graduating. New motivational strategies will be explored and implemented in Phases 3 and 4.

Future work will include data collection and assessment to determine levels of student participation in and effectiveness of the multi-year approach outlined here. Future strategies and programming may be modified based on student feedback or curricular updates.

Data will be limited to small cohorts from a single program. It will not be possible to disaggregate results for FE Exam pass rates. Transfer students and students on accelerated degree paths will not be distinguished. Residual effects from the covid pandemic may also have an unquantifiable impact on the results.

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