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Impact of Initial Phased Programing on FE Exam Encouragement for Mechanical Engineering Students

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Abstract

In this paper, the initial data from a multi-year approach is examined to establish notable trends for increasing encouragement of mechanical engineering students taking the FE Exam. At the University of Evansville, 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. Historically institutional pass rates have fallen below the national average. To improve institutional pass rates, faculty have developed a multi-year phased programming plan to provide additional resources and opportunities to encourage and support undergraduate students taking the FE exam before graduation. The first phase AY2023-24 involved course integrated strategies to help increase awareness and motivation at the freshmen and senior levels. Additional NCEES practice exams were made available to senior students for preparation. In the second phase, AY2024-25, the focus was to further increase preparation and awareness by integrating FE-style quiz problems into sophomore and junior level classes. Further FE practice exams were made available electronically on the ME program's LMS website. At the end of the second phase a survey was developed to help trend the impacts of the new programming. Early data show that awareness and motivation generally increase as the student matriculates. Motivation and importance are currently lower or the lowest for the senior cohort. It is notable that the senior cohort has also had the least exposure to the new programming that is being phased in. Further, 50% of the senior cohort from AY2024-25 used a combination of the NCEES Reference Manual and digital NCEES Practice Exam for preparation. Both resources have been part of Phase 1 and Phase 2 programming. Phase 3, AY 2025-26, and Phase 4, AY2026-2027, will continue to integrate more programming to help build intrinsic motivation in students. Future work will include continued data collection and assessment to determine levels of student participation in and effectiveness of the programming.

Introduction and Background

Mechanical engineering students at the University of Evansville School of Engineering and Computer Science (SECS) 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 mechanical engineering faculty and the program's Mechanical Engineering Advisory Committee. However, the formal FE review course offered by the SECS was discontinued in fall 2020 due to funding changes.

Multiple studies have shown that formal review courses and/or sessions are standard across many programs. The focus of these studies mainly centers on civil or environmental engineering programs [1]. 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 were seen to increase with the adoption of the additional elements [5].

Beyond preparation, student motivation and confidence have been considered factors that affect FE exam performance. A study conducted by Swenty et al. examined the perceived confidence and performance of students preparing to take the FE exam. Students completed FE style questions throughout a formal FE review course. The authors found that students had an increase in perceived confidence after completing the review course. These studies showed that the reinforcing of FE topics helps build student confidence and can have a positive effect on student performance. However, the authors could not correlate the increase in confidence to an increase in exam performance [6].

Beginning in spring 2022, the SECS made NCEES review materials available to students for independent review. As part of a longitudinal study, FE data was studied and presented in 2024. That work found that SECS 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 [7]. These results agree with the current trend of modifying FE review resources to be more self-led and increased online availability.

As part of the longitudinal study, faculty began developing strategies to develop and introduce additional programming to increase FE exam awareness and preparation strategies. These strategies were based on the trends identified by the works in the literature review. The programming was scheduled into four phases over a four-year period. The current work focuses on assessing the impact of the methods developed in the initial phases of the programming.

Methods

Phased programming was developed and implemented through all four years of undergraduate study. The programming developed includes both course-embedded material and optional programming outside the classroom. The new programming included FE-style quizzes, course-related discussions highlighting benefits of passing the FE, alumni feedback, and external speakers.

The mechanical engineering program also requires students to participate in a 4-year Integrated Design Sequence, where student teams participate in engineering design projects every Spring semester, and students from all cohorts can be selected to join a senior-led design project. There is an associated Integrated Design course for each year of study. These scheduled courses allow for targeted integration of material over all four years of study, in addition to freshmen and senior fall courses: introduction to mechanical engineering and senior design I.

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. Programming had already

existed for freshmen and seniors. Several instructors also referred 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 Phase 2, the FE Exam Resources on the Blackboard site were expanded to include some practice problems for self-guided student review. Additional FE-style practice problems were 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 were 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.

Optional programming available for students is summarized in Table 2 and grouped by academic year. Once introduced, most strategies were planned to be sustained as continuous offerings for future cohorts. As part of Phase 1 and Phase 2, exam review materials were made available through the Institution for students to check out. Further, the program hosted additional FE review materials on Blackboard, the LMS adopted by the Institution. Currently, the LMS includes the FE Reference Handbook, NCEES links, FE style practice questions, and general information about the topic areas covered on the "Other Disciplines" exam. Another part of Phase 1 and Phase 2 was to increase guest speakers, with some speakers being asked to include discussion of the importance or impact of a PE license in their career.

Phase 3 and Phase 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.

Ta*ble 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.

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*

Assessment

To assess the effectiveness of the programming outlined in this paper, a student survey was developed to help evaluate student awareness, motivation, and preparation for the FE Exam. Further awareness and motivation for obtaining PE licensure is also embedded in the survey. The survey is given to students at the end of each spring semester. The goal will be to collect data from each cohort as they matriculate through the program. By executing new programming in a phased strategy, each subsequent cohort will have had more FE-focused interventions than the previous cohort. Figure 1 is the survey completed by all cohorts at the end of the academic year. A Likert scale is used to quantify the student's responses.

Current Integrated Design Course: **ME 197** **ME 297** **ME 397** **ME 497**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Not Applicable**
I am aware of the requirements to take the FE exam.	1	2	3	4	5	n/a
The ME program has introduced me to the content covered in the FE exam.	1	2	3	4	5	n/a
The ME program has introduced me to FE exam preparation tools available through the ME program and SECS.	1	2	3	4	5	n/a
I feel encouraged by the Mechanical Engineering program to pass the FE Exam.	1	2	3	4	5	n/a
Passing the FE exam is an achievable goal for me in the future.	1	2	3	4	5	n/a
I plan to familiarize myself with FE exam resources and study materials.	1	2	3	4	5	n/a
I believe preparing for the licensure exam in advance will be beneficial.	1	2	3	4	5	n/a
I am likely to dedicate significant study time specifically for the FE Exam.	1	2	3	4	5	n/a
Passing the FE exam as a student is beneficial.	1	2	3	4	5	n/a
I believe that obtaining a PE license will enhance my career opportunities.	1	2	3	4	5	n/a
I believe professional licensure reflects a commitment to professional growth.	1	2	3	4	5	n/a
I perceive licensure as a worthwhile investment of my time and effort.	1	2	3	4	5	n/a
I am motivated to pursue professional licensure as part of my long-term career planning.	1	2	3	4	5	n/a
Discussions or information presented in my Mechanical Engineering courses have positively influenced my perception of the importance of professional licensure.	1	2	3	4	5	n/a

Figure 1. Student survey with questions given to all students.

An additional set of questions are provided only to the seniors. The question set limited to seniors focuses more on preparation and resources used to prepare. Again, a Likert scale is used to quantify the student responses. Also, the last section of the survey was used to identify and trend the study materials the students used to prepare for the FE. Figure 2 contains the additional questions for seniors.

These questions are FOR SENIORS ONLY

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
The FE exam covered topics I expected based on my preparation.	1	2	3	4	5	n/a
I felt adequately prepared for the FE exam based on my academic coursework.	1	2	3	4	5	n/a
The study resources I used were effective in helping me prepare for the FE exam.	1	2	3	4	5	n/a
I dedicated significant time to studying for the FE exam.	1	2	3	4	5	n/a
I gave my best effort on the FE Exam.	1	2	3	4	5	n/a
Passing the FE exam on my first attempt is important to me.	1	2	3	4	5	n/a

Which resources did you use to prepare for the FE Exam? Select all that apply.

- ☐ Course Notes
- ☐ Course Textbooks
- ☐ NCEES FE Reference Manual
- ☐ NCEES Practice Exam (SECS Office)
- ☐ NCEES Digital Practice Exam (Blackboard ME Hub)
- ☐ The Interactive Practice Exam (purchased via NCEES website)
- ☐ Other Published FE Review Manual/Study Guide
  circle one: hardcopy / digital version
- ☐ Online Review Videos
- ☐ Online Review Courses
- ☐ Nothing
- ☐ Other: _____

Figure 2. Senior only questions from assessment survey.

The survey was administered for the first time in Spring 2025. The mapping of the questions is shown in Table 3. Based on the mapping, the average response for each question was then used to quantify the overall response on the established Likert scale for each area of concern: awareness, importance, and motivation.

Table 3. Mapping of survey questions for FE awareness, importance and motivation.

Question	FE Awareness	FE Importance	FE Motivation
1	x		
2	x		
3	x		x
4			x
5			x
6	x		x
7	x	x	x
8		x	x
9		x	x

Further, a mapping of the PE licensure questions is provided in Table 4. The focus of these questions was perceived importance and student motivation to obtain PE license. Again, the average response of each question was used to quantify the overall response to the mapped theme using the established scale.

Table 4. Mapping of survey questions for PE importance and motivation.

Question	Licensure Importance	Licensure Motivation
10	x	x
11	x	
12	x	x
13		x
14	x	

A complete summary of initial student responses, as mapped to the five identified themes of interest, is shown in Figure 3. The overall response rate for the survey was 81%. The total number of responses and response rates for each cohort are shown in the legend of Figure 3. It was found that both awareness and motivation increase as students matriculate. Overall, students highly agree that both the FE and PE licensure are important, independent of their class standing. A concerning result is that agreement across all areas decreases for the senior cohort. It should be noted that the phased programming has not been fully installed, so the seniors would have been exposed to fewer interventions than underclassman had.

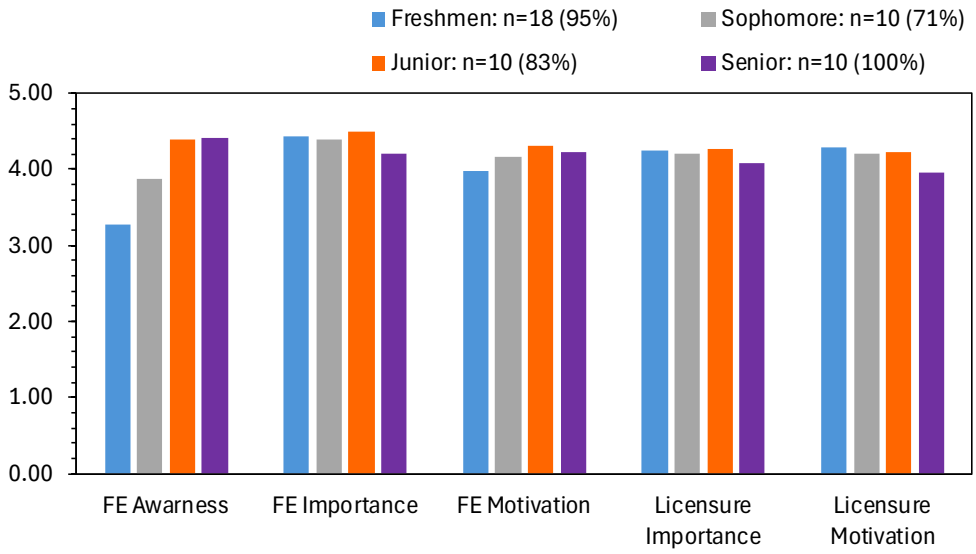

Figure 3. Summary results from assessment survey.

In addition to quantifying student awareness, perceived importance, and motivation for the FE and PE, the survey was also used to assess student preparation. Preparation was assessed using the additional questions for seniors, as they had recently attempted the FE exam. Table 5 presents the mapping of the questions only answered by the seniors; The corresponding results are presented as averaged values in Figure 4.

Table 5. Mapping seniors only survey questions to FE preparedness, importance and motivation

Question	FE Preparedness	FE Importance	FE Motivation
15	x		
16	x		
17	x		
18		x	x
19		x	x
20		x	x

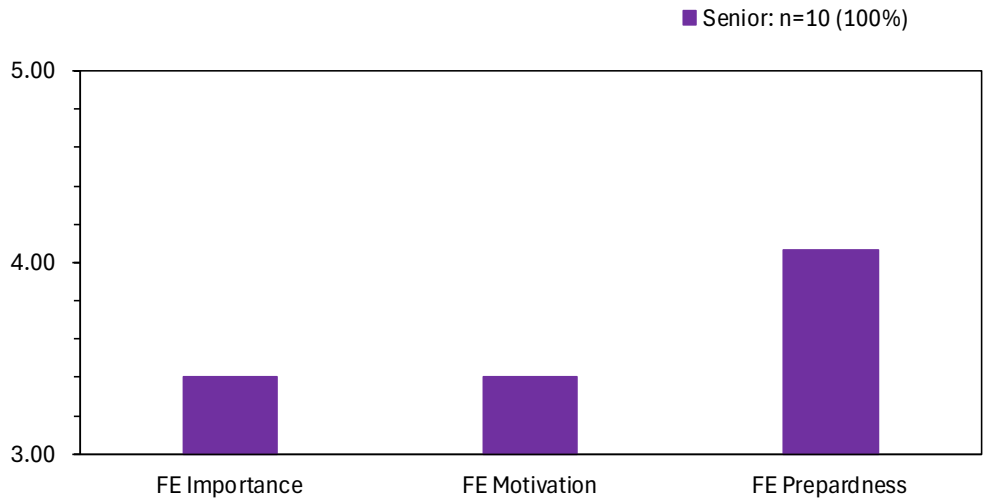

Figure 4. Summary results from assessment survey, senior only section.

The result seen in Figure 4 is lower than the senior response for importance and motivation shown in Figure 3. However, due to the small sample size this difference is not statistically significant. Seniors generally agree that they feel prepared for the exam. Considering preparation, the seniors were also asked to identify what materials or resources they used to study or prepare for the FE exam. The seniors could select all the options that they utilized, and the options they had to choose from can be seen in Figure 2. The results are summarized in Figure 5. Half of the seniors surveyed used course notes, the FE reference manual, and ME Blackboard review materials to prepare for the exam. The NCEES Practice Exams made available by the Institution were used by about 40% of the seniors. These results indicate that several of the materials introduced are being utilized. Two out of ten students responded that no materials had been used to prepare.

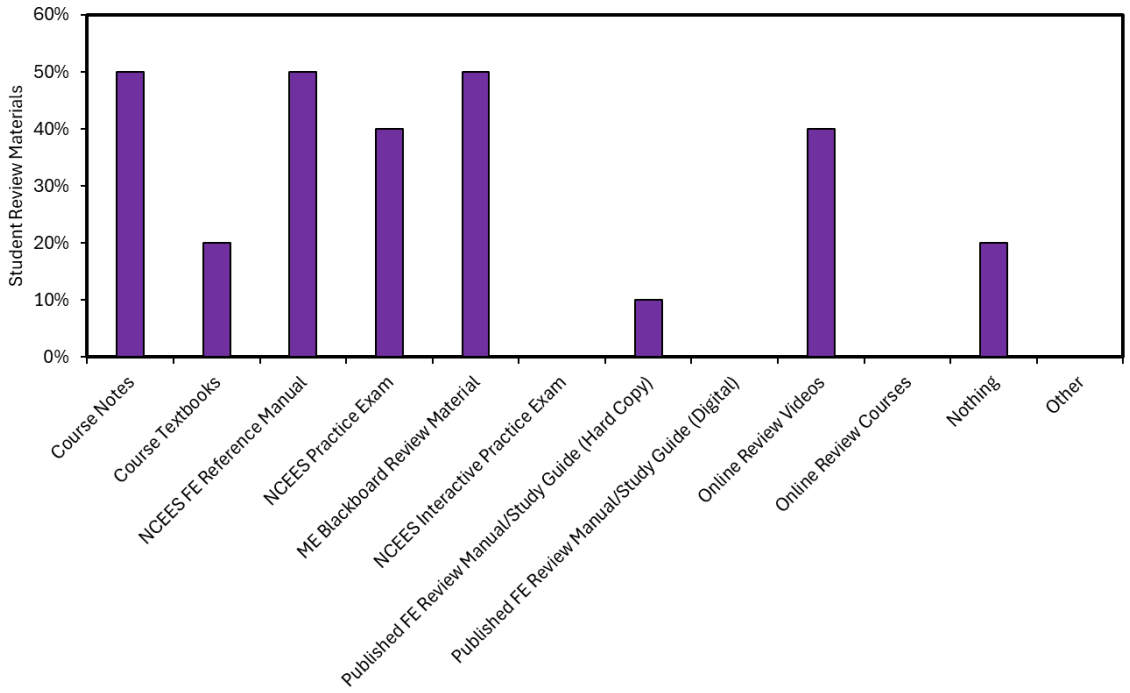

Figure 5. Summary of review materials used to prepare for the FE exam (seniors only).

Conclusions and Future Work

This paper outlines the assessment of the initial phases of a plan for introducing additional scaffolding and encouragement for students in a Mechanical Engineering program where attempting the FE Exam is a graduation requirement. This work focused on the assessment of Phase 1 and Phase 2 of the new programming. These phases included the introduction of FE-style quiz questions into required courses at the sophomore and junior level. The FE Reference Handbook was also incorporated into these sophomore and junior level courses. Further additional FE review materials were made available to students both in hard copy and digital formats. These phases also focused on increasing the out-of-class programming for students, which included guest speakers and highlighting alumni that obtain PE licensure.

A student survey was developed to assess the impact of phased programming on students. The survey is given at the end of each spring to all students in the mechanical engineering program. The survey has been administered one time in Spring 2025. The results showed that there is an increase in awareness and motivation of the FE exam as students matriculate. The senior responses were lowest for perceived importance and motivation to obtain professional licensure. This trend may be due to not all programming being instituted for the senior cohort. As additional programming is implemented, students should experience more consistent exposure to FE-related interventions at all levels of study. Further, the seniors surveyed used the new FE review materials for their preparation which corresponded to a positive perception of preparedness.

Future work will include continued data collection and assessment to determine levels of student participation in and effectiveness of this multi-year approach. Also, FE exam pass rates will be

examined and possibly correlated with student survey results. Future strategies and programming may be modified based on student feedback or curricular updates.

Data is 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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