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Empowering Engineering Students for the FE Exam: Classroom Integration and Customizable Study Strategies

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Empowering Mechanical Engineering Students for the FE Exam: Classroom Integration and Customizable Study Strategies

Abstract

Preparing undergraduate engineering students for the Fundamentals of Engineering (FE) exam is essential for supporting licensure readiness and professional development. At our institution, we developed a multifaceted strategy to assist students from various disciplines—including Mechanical, Electrical, Civil, and Environmental Engineering—in preparing for the exam. Our approach combined in-class presentations aligned with National Council of Examiners for Engineering and Surveying (NCEES) exam topics, face-to-face review sessions, asynchronous online modules recorded by faculty, and a customizable study program that allowed students to focus on the subject areas most relevant to their discipline and career goals. This structure addressed diverse academic backgrounds, learning preferences, and scheduling constraints while offering equitable access to high-quality preparation resources.

Historically, Environmental engineering students at our institution began taking the FE exam in 1997, for Mechanical and Electrical Engineering students, the exam became mandatory in 2022, and for Civil engineering students first participated in 2024. In 2023, we launched a structured faculty-led preparation program, which significantly expanded the support available to students. Initially, only the study materials were funded for students, but in 2024, we received a grant from a private non-profit foundation that covered both the $225 exam registration fee and the $145 cost of a third-party vendor online study materials. This financial support removed a major barrier for many students and increased participation.

To evaluate the impact of these strategies, we collected student outcome data from 2022 to 2025. Among Electrical, Environmental, and Mechanical Engineering students, the FE exam pass rate increased from 49% in 2022-2023 to 67% in 2024-2025. For Mechanical Engineering alone, the pass rate improved from 41% in 2022-2023 to 77% in 2024-2025. Student survey responses also reflected higher levels of confidence, preparation, and awareness of exam content. This paper presents the evolution of our FE preparation program, emphasizing in the ME program, summarizes and institutional policies grant support, and offers actionable insights for other institutions seeking to improve licensure exam readiness in a multidisciplinary engineering context.

1. Introduction and Background

The Fundamentals of Engineering Exam (FE) is the first of two examinations required to become a licensed Professional Engineer (PE) in the United States. The FE was developed by the National Council of Examiners for Engineering and Surveying (NCEES) (1). The FE exam has evolved since it was first administered nationally in 1965 to promote uniform licensure standards across the United States. For several decades, the exam was a paper-and-pencil test consisting of 180 questions, divided into two, four-hour sessions. NCEES officially retired the pencil-and-paper format to the FE exam in late 2013. Starting January 3, 2014, all FE exams transitioned to Computer-Based Testing (CBT) offered at professional testing centers year-round instead of only twice a year. The move to CBT resulted in the exam being shortened from 8 hours to 6 hours and the number of questions was reduced from 180 to 110 (1). The morning "general" section was removed and core topics (e.g. Math, Ethics) were integrated into seven distinct discipline exams (Chemical, Civil, Electrical, Environmental, general, Industrial and Mechanical). The transition also replaced physical reference manuals with a searchable electronic PDF version of the NCEES FE Reference Handbook (2).

The main goal of the FE exam is to test the minimum Engineering knowledge and skills obtained by a student enrolled in an Accreditation Board for Engineering and Technology (ABET) accredited college engineering program to protect the public's health, safety, and welfare (3). The exam validates the academic knowledge of an individual student against a national standard. Most students will sit for the exam during the final year of an undergraduate curriculum while the student is still familiar with the foundational coursework concepts. Passing the exam demonstrates that a student has mastered foundational engineering principles and also designates the individual as an Engineer-In-Training (EIT), which has been found to enhance their career prospects, as well as serving as a mechanism to increasing professional responsibilities. Many employers view the passing of the FE exam as evidence of dedication to the profession and mastery of foundational technical skills, making candidates more attractive than those without the certification. The NCEES provides reports of student performance on the FE exam to universities, many of which use the date for program assessment and ABET accreditation purposes (4).

Universities typically utilize the FE exam as undergraduate engineering programs as a multifaceted tool for undergraduate engineering programs, primarily focusing on academic assessment, graduation requirements, and professional preparation. The exam results are important tools for outcomes assessment and curriculum preparation (5,6,10).

To promote student success, universities will implement various formal and informal preparation strategies. Examples are summarized below in Table 1:

Table 1. Examples of Formal and Informal FE Preparation Tools (7,8,9,11,12)

Curriculum Integration	Supplementary Resources
Review Courses: Some programs offered specialized "professional practice" or review courses.	*Review Sessions*: Some universities provided optional review sessions outside of regular class hours.

Curriculum Integration	Supplementary Resources
Embedded FE Topics: Some programs require specific courses that cover all topic areas tested on the FE Exam	*Learning Management Systems (LMS) and Digital Tools*: Integrating FE-style questions into LMs and utilize professional resource review manuals and online practice problems
	Instructional Media: Students are directed to external resources such as FE review videos on YouTube

University advisors will also typically recommend to their students a structured study plan that will include topics such as: becoming familiar with the NCEES reference handbook; utilizing timed practices; and advising students to review and focus on topics with the highest number of questions according to NCEES specifications. Universities and students typically utilize a combination of official NCEES materials and third-party commercial resources. The goal is often to balance cost-effectiveness with high-quality practice questions that mimic the actual computer-based testing (CBT) environment.

The three ABET-accredited programs: Environmental, Electrical and Mechanical, and Civil engineering program currently seeking its initial ABET accreditation at our institution, currently require all matriculated students to sit for the FE exam as a graduation requirement. At our institution, Environmental engineering students began taking the FE exam as early as 1997. The exam became a graduation requirement for Mechanical and Electrical engineering students in 2022, while Civil engineering students took the exam for the first time in 2024. To assist students in understanding the process of professional licensure, the FE / EIT process is introduced in an engineering ethics course that is required of all engineering students. Discipline specific approaches to the exam are covered by many of the engineering instructors in their respective courses. A non-profit foundation, in collaboration with an industry group and with funding from the state, established a statewide *Take the FE Exam* initiative to encourage students to begin the journey to professional licensure among engineering students through support for the FE examination. Specifically, the *Take the FE Exam* initiative provided students with financial assistance for the registration fee as well as access to study materials from a third-party vendor that supplies FE exam prep materials. Our institution was an active participant in this initiative, which provided financial and academic assistance to a total of 250 students across participating institutions. This program played a meaningful role in reducing barriers to licensure by subsidizing the cost of FE examination preparation materials and registration fees. This support enabled our institution engineering students to more effectively prepare for the exam and begin the licensure process at an early stage. Administrators at our institution facilitated the distribution of resources.

In response to the increasing importance of licensure, Mechanical Engineering (ME) department implemented a comprehensive preparation program that includes face-to-face review sessions, online recorded content, a customizable study plan, and a faculty-led preparation course. This initiative was further supported by institutional funding to reduce financial barriers to participation.

Although the FE exam is widely recognized as a critical milestone, to our knowledge for engineering students, there is limited literature describing structured, department-level preparation programs—particularly those that combine flexible instructional formats, financial support, and long-term outcome data. This paper addresses that gap by presenting the design, implementation, and impact of a multifaceted FE exam preparation strategy, with a specific focus on Mechanical Engineering (ME) students between 2022 and 2025.

2. Methodology

While the broader program included other disciplines such as Electrical, Civil, and Environmental engineering, this paper emphasizes ME students due to the availability of multi-year data and the implementation of different modes of instruction.

2.1 Development Timeline and Institutional Context

The FE preparation initiative evolved in response to institutional goals for professional licensure and student readiness. For ME students, the FE exam became a graduation requirement beginning in 2022. In spring 2023, the department launched a faculty-led preparation course, and in 2024, a grant enabled full financial support for both exam registration and study materials. These developments marked a significant shift from previous years, when participation was voluntary and self-guided.

2.2 Modes of Instruction

The preparation program included multiple modes of instruction designed to increase access, flexibility, and content relevance.

2.2.1. Face-to-Face Review Sessions

- Delivered once per week across academic terms: During the 2023–2024 academic year, the course was offered in the first half of the spring semester. During the 2024–2025 academic year, it was offered in both the second half of the fall semester and the first half of the spring semester.
- Conducted by ME faculty with expertise in key exam content areas and integrated into existing ME courses.
- Emphasis was placed on core topics identified in the NCEES FE ME exam specification, including but not limited to statics, dynamics, thermodynamics, fluid mechanics, heat transfer, and machine design.
- Sessions reinforced course content while providing exam-oriented problem-solving strategies tailored to the structure, pacing, and breadth of the FE exam.
- While no formal grading was applied, students received ongoing feedback and support.

2.2.2. Online Recorded Sessions

- Pre-recorded lecture-style videos created by faculty and made available through the university's Learning Management System (LMS), specifically the D2L Brightspace platform. The videos have been available since the first half of the spring semester 2024.
- Videos were topic-specific and aligned with the NCEES ME exam specification.
- No quizzes or assessments were included; the goal was to provide flexible, on-demand content review for students with varied schedules or academic needs.

2.2.3. Customizable Study Program

- Students were encouraged to reflect on their coursework performance and identify areas for review using NCEES guidelines.
  Faculty provided one-on-one or small group advising to help students develop a personalized study plan using a third-party vendor online platform. Study materials have been provided since 2018 to anyone wanting or needing to take the FE exam.
- The plan focused on core areas most relevant to ME and leveraged both face-to-face and online resources.

This face to face course served students who preferred a structured environment with consistent faculty guidance over fully independent study.

2.3 Financial Support for Students

Financial barriers were a major concern, particularly given the combined cost of FE registration ($225) and third-party vendor study materials online study materials ($145). In 2018, the department subsidized only the cost of study resources. In 2024, a grant from a foundation allowed the department to cover both costs for graduating seniors:

- All eligible students received vouchers or reimbursements.
- The funding was critical in boosting participation and reducing stress for students facing economic hardship.

2.4 Data Collection and Analysis

To evaluate program effectiveness, we focused on data from ME students between 2022 and 2025. Data sources included:

- **Annual FE exam pass rates** reported by students and verified through departmental tracking and comparison with the national ABET pass rate.
- **End-of-semester surveys** administered to ME students enrolled in the FE prep course or participating in the study program.

Pass rates were used as the primary outcome measure, supplemented by qualitative feedback from students regarding the value and accessibility of the program components.

A detailed timeline and summary of the student support initiatives is given in Table 2 for Mechanical Engineering majors.

Table 2. Support initiatives for the different academic years

Academic Year	Interventions / Details
2017-2018, 2018-2019, 2019-2020, 2020-2021	- Started to provide FE Prep from a third-party vendor that supplies Online FE exam prep materials to those interested in taking the FE exam. **FE Exam was optional**.
2021-2022	- Attempting FE exam became mandatory for ME majors. - FE Prep from a third-party vendor that supplies Online FE exam prep materials was provided to all graduating seniors. They used it at their discretion. **All graduating ME seniors took the FE exam**
2022-2023	- FE Prep from a third-party vendor that supplies Online FE exam prep materials was provided to all graduating seniors. They used it at their discretion. **All graduating ME seniors took the FE exam.**
2023-2024	- FE Prep from a third-party vendor that supplies Online FE exam prep materials was provided to all graduating seniors. They used it at their discretion. - Recorded modules were made available since the first half of the spring semester 2024. - Face-to-face review sessions were offered only during the first half of the spring semester. - Attendance was optional. **All graduating ME seniors took the FE exam.**
2024-2025	- The grant from the foundation provided the FE Prep from a third-party vendor that supplies Online FE exam prep materials and covered the FE exam registration fee for all graduating seniors. Face-to-face review sessions were offered during the whole academic year. Attendance was optional. - Recorded modules were still available online the entire academic year **All graduating ME seniors took the FE exam.**

2.4 Statistical Analysis

Data were collected from 96 students across three academic years (2022–2025), including individual cumulative GPA and FE exam outcomes (pass/fail). Incomplete student-level records from the 2021–2022 cohort were excluded. FE exam outcomes were coded as a binary variable (pass = 1, fail = 0). A point-biserial correlation analysis was first performed to assess the association between GPA (continuous variable) and FE exam outcome (binary variable). Subsequently, a logistic regression model was used to evaluate GPA as a predictor of FE exam success. The model was specified with FE exam outcome as the dependent variable and cumulative GPA as the primary predictor. Cohort year was also included as a categorical fixed effect to account for differences between academic years and preparation conditions. Missing data were handled using listwise deletion; therefore, only students with complete GPA and FE outcome records were included in the analysis. Statistical significance was evaluated at $\alpha = 0.05$. Odds ratios (OR) and 95% confidence intervals were computed to quantify effect size and practical significance.

In addition to student-level modeling, a cohort-level linear regression analysis was conducted to examine the relationship between average cohort GPA and overall FE exam pass rate. Using academic year as the unit of analysis (n = 4 cohorts), a first-order linear model was fit in Excel to generate the trend line shown in Figure 1. Predicted pass rates represent values estimated from this descriptive model and serve as a benchmark for comparing observed cohort performance. Because this regression is based on a limited number of cohort-level observations, it should be interpreted as descriptive rather than inferential.

3. Results and Discussion

3.1 Overall FE Exam Performance by Academic Year

Table 3 summarizes FE examination outcomes for ME students at our institution from academic years 2021–2022 through 2024–2025. Over this period, both participation and performance exhibited notable changes. The national FE pass rates remained relatively stable (approximately 71–73%). Our institution ME student pass rates showed substantial variability, ranging from a low of 39.1% in 2023–2024 to a high of 77.3% in 2024–2025. The FE exam pass rate vs. GPA for cohorts is shown in Figure 1. Predicted pass rates were calculated using a logistic regression model in which GPA was used as a continuous predictor of FE exam success. Cohort-level predicted values were obtained by averaging model-estimated probabilities for students within each academic year. The predicted pass rate represents the expected FE exam success for each cohort based solely on its GPA distribution, derived from a regression model fit to student-level outcomes in years with complete individual data. The difference column in Figure 1 shows if a cohort over performed or underperformed based on GPA alone.

Table 3. Overall Cohort Pass Rate

Avg. GPA	Standard deviation	Academic Year	Pass	Fail	Total # students	National Average	Our institution Pass Rate	Predicted from Trend Line	Difference
3.41	0.42	2021-2022	17	16	33	71%	51.5%	55.9%	-4.4%
3.13	0.42	2022-2023	12	17	29	71%	41.4%	34.0%	7.4%
3.36	0.40	2023-2024	9	14	23	73%	39.1%	52.1%	-13.0%
3.56	0.39	2024-2025	17	5	22	73%	77.3%	67.3%	9.9%

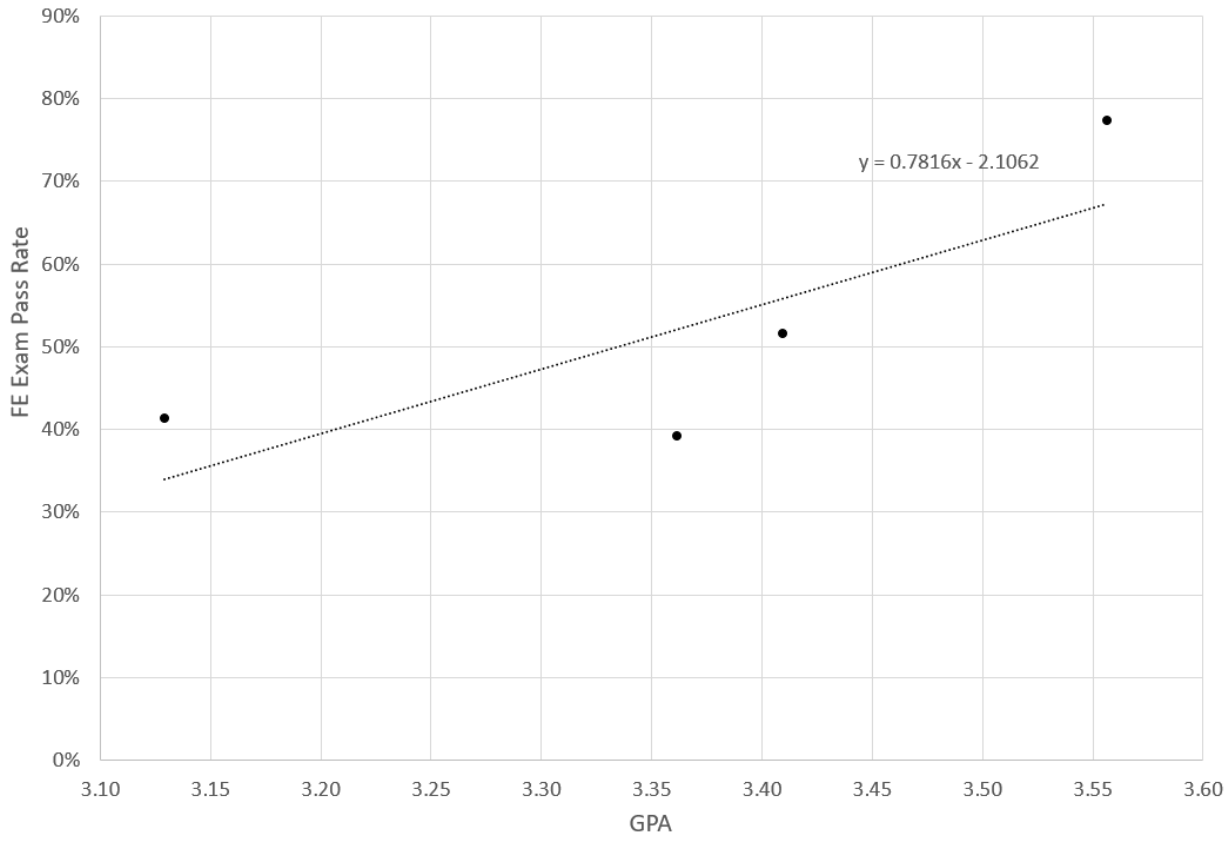

Figure 1. FE Exam Pass Rate vs. GPA for Cohorts.

The most significant improvement occurred in the 2024–2025 academic year, during which our institution pass rate exceeded both the national average and the predicted pass rate. This improvement coincided with a higher average cohort GPA, expanded faculty-led

preparation, earlier exposure to exam content, and full financial support for exam fees and study materials.

3.2 GPA-Adjusted Performance and Predicted Pass Rates

The difference between observed and predicted pass rates provides insight into whether a cohort performed above or below expectations based on GPA alone. For example, the 2024–2025 cohort achieved an observed pass rate of 77.3%, exceeding its GPA-predicted rate of 67.3% by nearly 10 percentage points. In contrast, the 2023–2024 cohort underperformed relative to GPA-based expectations, with an observed pass rate 13 percentage points below its predicted value. These deviations are consistent with the presence of factors beyond academic performance in FE exam success.

3.3 FE Exam Performance by GPA Range

Figure 2 illustrates FE pass rates stratified by GPA range (2.00–2.49, 2.50–2.99, 3.00–3.49, and 3.50–4.00) for the 2022–2023 through 2024–2025 cohorts. Individual student-level data were not available for 2021–2022 and were therefore excluded from this analysis.

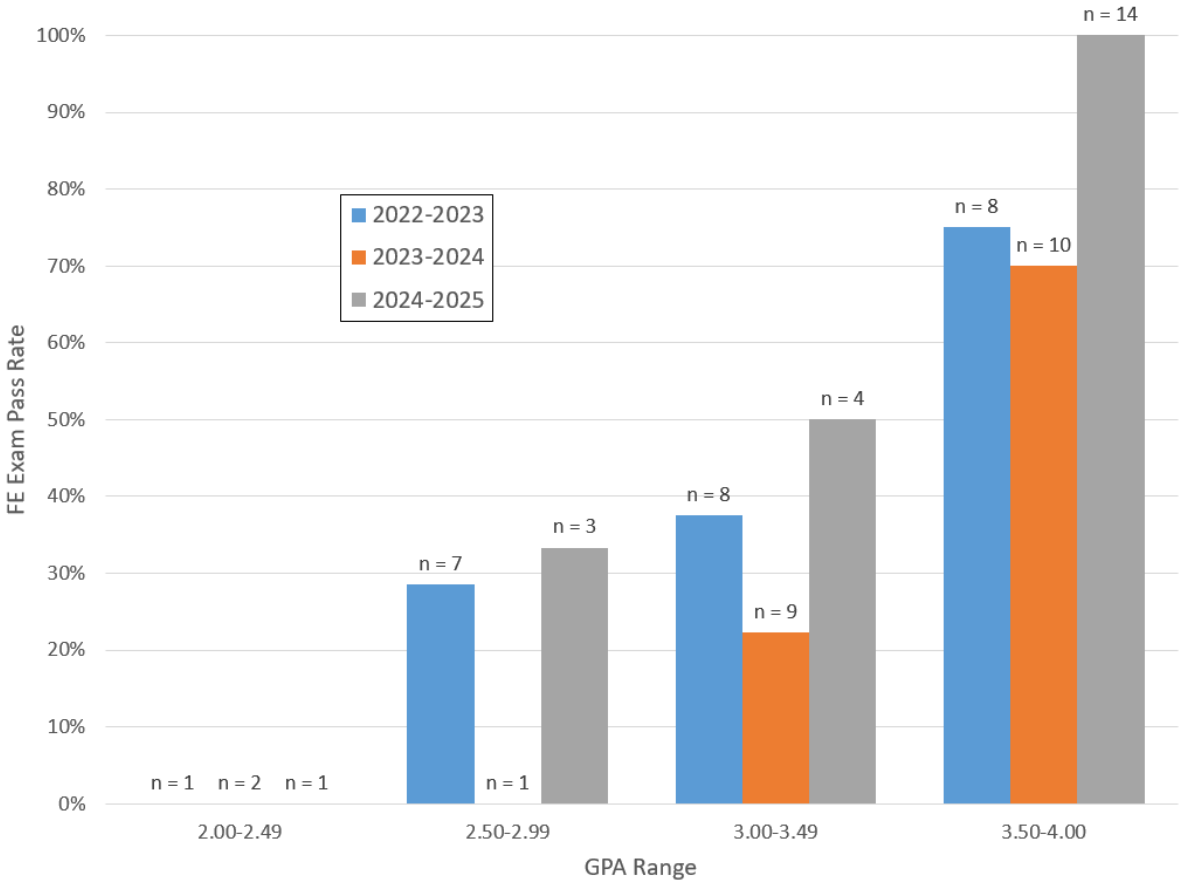

Figure 2. FE Exam Pass Rate vs. GPA Range

Across all cohorts, higher GPA was consistently associated with higher pass rates, supporting GPA as an important predictor of FE exam success. However, the magnitude of this relationship varied substantially by year. The 2024–2025 cohort outperformed previous cohorts

in every GPA category, including the lower GPA ranges, indicating a broad-based improvement rather than gains limited to high-performing students.

Figure 3 presents the number of FE exam failures by GPA range for the same three cohorts. A particularly noteworthy outcome is observed in the 2024–2025 academic year: all students with GPAs between 3.50 and 4.00 passed the FE exam, whereas prior cohorts consistently exhibited failures even within this highest GPA range. This result is relevant, as it demonstrates that strong academic performance alone has not historically guaranteed FE success and suggests that the enhanced preparation structure contributed meaningfully to improved outcomes.

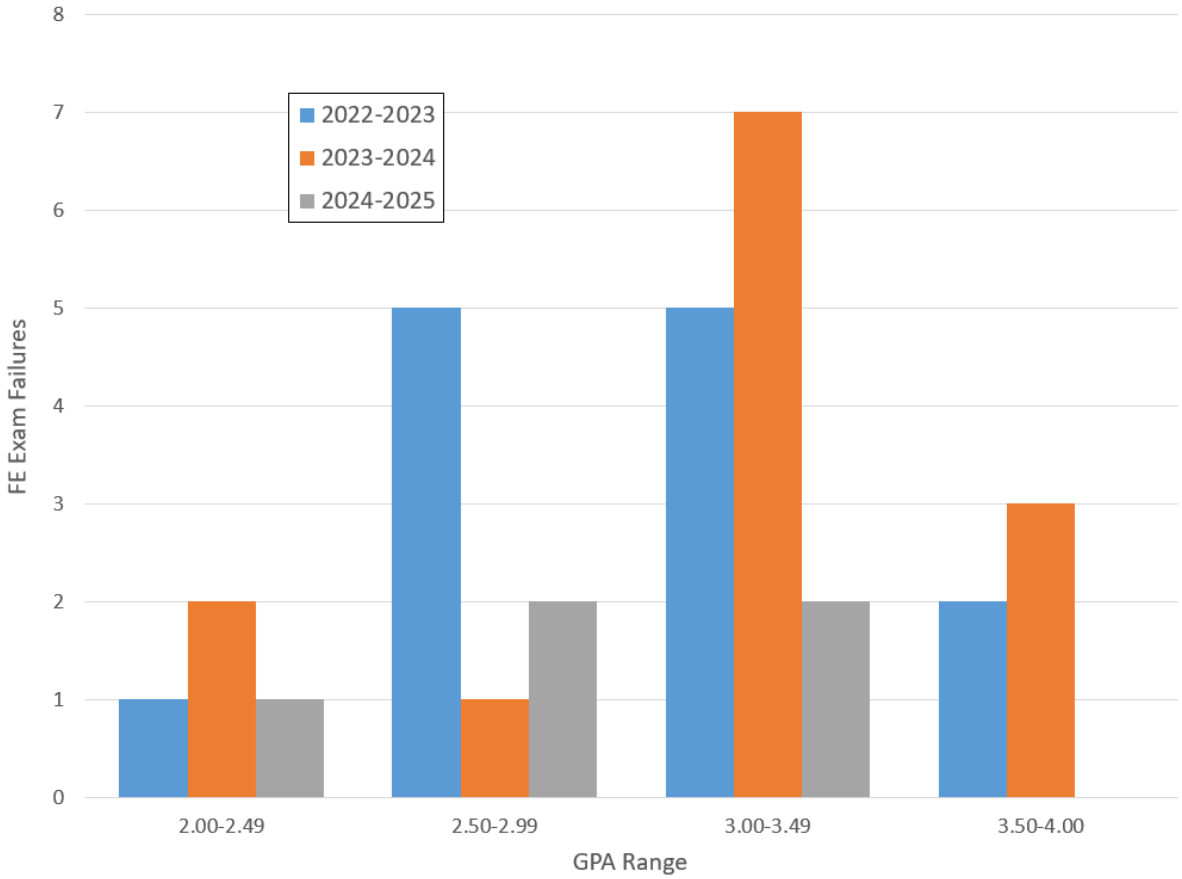

Figure 3. FE Exam Failure vs. GPA Range

Further comparison between the last two cohorts reinforces this conclusion. In 2023–2024, only 47.3% of students with GPAs above 3.00 passed the FE exam, despite generally strong academic records. In contrast, 88.9% of students above this GPA threshold passed in 2024–2025. Given that the average GPA increased only modestly between these cohorts, the magnitude of the pass-rate improvement cannot be attributed to GPA alone.

3.4 Statistical analysis

To evaluate GPA as an individual-level predictor of FE exam success, logistic regression analysis was conducted using student-level pass/fail outcomes. The point-biserial correlation analysis revealed a statistically significant positive association between GPA and FE exam outcomes ($p = 0.013$), indicating that students with higher GPAs were more likely to pass the exam. Logistic regression results further confirmed that GPA was a statistically significant predictor of FE exam success ($p = 0.004$). However, the model explained only a modest portion of the variance in exam outcomes (pseudo $R^2 \approx 0.12$), suggesting that GPA alone does not fully account for observed pass rates. Notably, cohorts during years in which structured faculty-led preparation and financial support were implemented demonstrated pass rates that exceeded GPA-based predictions. These findings indicate that while GPA contributes to exam readiness, institutional interventions played a critical role in improving FE exam outcomes beyond what academic performance alone would predict.

3.5 Impact of Instructional Timing, Structure, and Culture

Differences in instructional timing and intensity appear to explain much of the observed variation. During the 2023–2024 academic year, faculty-led FE preparation sessions were optional and introduced relatively late in the spring semester. As a result, many students likely sat for the FE exam before completing or fully benefiting from these sessions. In contrast, the 2024–2025 cohort received structured preparation across both the fall and spring semesters, allowing for sustained engagement with exam content, reinforcement of core topics, and repeated exposure to FE-style problem-solving strategies.

Requiring the FE exam as a mandatory component of engineering education represents a significant cultural shift. Typically, graduation is seen as the finish line, but licensure reframes graduation as the real starting point of professional responsibility. Faculty play a key role to promote licensure, and sometimes it takes time to get faculty buy-in, especially if they are accustomed to non-PE career paths. Faculty advocacy is crucial for students to take the exam seriously. If they are silent about licensure, it may unintentionally signal that licensure is irrelevant. As faculty buy-in continues to strengthen over the years, student success is expected to increase as well.

Clearly evidence strongly suggests that taking the FE exam will be beneficial to students in the long run. It sets them firmly on the path to become a PE and differentiates them as a candidate who can bring more value when being viewed by potential employers. These benefits are meaningless however if the student does not take advantage of them. Providing subsidized access to the online study materials and help covering the exam fee gives students an incentive to take advantage of them without worrying about having another financial burden to account for. Students from the cohort who were covered under the "*Take the Exam"* program were asked to comment on the Senior Exit Survey given in April 2025. The survey was set up on Google Forms and the students were given a QR code to access the survey. The response rate to the survey was 29 out of 32 graduating students. One open-ended question specifically asked them "Please give any comments regarding the grant that funded the online FE study materials from PPI and the cost of the exam. (E.g. How did this benefit you? Were the online study materials useful?)". The comments were overwhelmingly positive, with students describing the study materials using comments such as "useful," "very beneficial," "helped drastically," and "an excellent resource." In addition, several students specifically made note that not having to

personally cover the cost of the study materials and exam helped remove some of the stress from taking the exam, and helpful as some students noted that they did not have the money available to cover the costs themselves. Based on the student comments it does not appear to be indefensible to state that providing the online study materials to students on a no cost basis along with covering the exam fee provides large benefits for modest investments. These data sources allowed for year-over-year comparisons of pass rates, GPA-adjusted performance, and subgroup analyses by GPA range.

4. Conclusions and Future Work

While GPA remains a significant predictor of FE exam success, it does not fully explain the observed pass rates. The notable overperformance—ranging from 39.1% in the 2023–2024 cohort to 77.3% in the 2024–2025 cohort, relative to GPA-based expectations—suggests that early, sustained, structured faculty-led preparation, additional self-study prep materials, along with financial support, can significantly enhance outcomes.

This improvement reflects a broader cultural shift within the department, where FE preparation evolved from an optional, last-minute activity into a normalized, integral component of the engineering curriculum. Students increasingly viewed the FE exam not as an isolated hurdle but as a shared professional milestone, supported through faculty mentorship, peer collaboration, and institutional resources.

These findings underscore the critical role of institutional commitment and intentional instructional design in promoting licensure readiness among engineering students. They demonstrate that, with the right support systems in place, engineering programs can empower students to exceed traditional performance benchmarks and pursue professional licensure with greater confidence.

Furthermore, the approach presented in this study is designed to be transferable to peer institutions, particularly those operating with limited resources. By emphasizing structured preparation, peer support, and faculty mentorship, similar improvements in FE exam outcomes could be achieved in a variety of academic contexts.

We believe that the minimum viable support is providing the FE Prep materials from a third-party vendor that supplies Online FE exam prep materials. This study confirms the benefits of several critical components to support FE requirements reported by other institutions and will serve to be the framework that our institution plan to use going forward to support students taking (and successfully passing) the FE Exam. These include using:

Dedicated Review – Offering review materials to senior engineering students to refresh their technical knowledge and to review specific test-taking strategies

Financial Support – Reimbursement policies for registration and third-party test-prep materials incentivize passing and reduce the financial burden on students

Multi-Year Engagement – Increasing licensure awareness during a student's academic tenure by sharing alumni feedback and bringing in guest speakers to highlight the career benefits of the PE license

Importantly, we will continue to collect and analyze data to monitor student success rates and refine our strategies over time. The role of external funding—especially through competitive grants—has also been instrumental in launching and scaling these efforts. Such funding has enabled financial support for students, covered exam fees, and facilitated faculty development opportunities, all of which contribute to the program's sustainability and impact.

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