

## Department Policy and Programs that Support NCEES FE Exam Prep in Civil and Environmental Engineering

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# **Student Perspectives and Online Visibility of Department Policy and Programs that Support NCEES FE Exam Prep in Civil and Environmental Engineering – Selected Perspectives**

## **Abstract**

One of the first steps toward becoming a professional engineer (PE) is passing the National Council of Examiners for Engineering and Surveying (NCEES) Fundamentals of Engineering (FE) exam. Due to the importance of professional licensure in the fields of civil and environmental engineering, undergraduate students studying in these fields are often highly encouraged to take the FE exam during their final year at college or shortly after graduation. To investigate the existing support for FE exam prep in undergraduate civil and environmental engineering (CEE) departments, this study benchmarked related policies and programs visible on department websites at the top 50 largest civil engineering institutions. Almost half of the benchmarked CEE department websites displayed a low visibility of the FE Exam, indicating that finding any material on the FE exam on CEE websites was indirect or not existent. To capture attitudes and perceptions towards FE exam resources, an online survey was distributed to CEE student clubs at each of these at these institutions (n=143). The findings indicate that although students generally felt encouraged to take the FE exam, improvements need to be made to fully support and facilitate their exam prep endeavors. Key recommendations include providing a clear timeline of FE / PE licensure and access to free online review materials through department websites. Students should be exposed to the process and importance of licensure throughout their academic journey by introducing the FE exam as a degree-long goal, including the exam on 4-year plan advising sheets, FE-style questions in technical courses, and discussions of the licensure process in capstone courses. Departments may strongly consider offering an optional or required FE review course to refresh exam topic knowledge, share test-taking skills, and encourage peer study environments. Additionally, departments may consider developing a scholarship/reimbursement policy for a portion of the exam registration costs if a student passes to promote exam pass rates and reduce the student's financial burden.

## **Introduction**

Earning a professional engineering (PE) license is an important step many engineers take to open career doors, protect the public, and provide credibility for their engineering skillsets. In the field of civil and environmental engineering (CEE) receiving professional licensure is especially important as it often deals directly with the built environment and the public [1]. One of the first steps towards professional engineering licensure is passing the National Council of Examiners for Engineering and Surveying (NCEES) Fundamentals of Engineering (FE) exam. After passing the FE exam, applicants must graduate from an ABET-accredited engineering program, gain work experience, and pass the Principles and Practice of Engineering Exam [2]. Additionally, ABET accreditation guidelines for civil engineering programs require departments to conveying the importance of professional licensure. Standardized online FE exams are offered in seven disciplines, but the FE civil has the largest participation by volume of exams; approximately 44.5% of all FE exams taken from July-December 2021 were FE civil exams and 5.5% were FE environmental exams [2]. Although environmental FE exams only represent a small proportion, these exams are associated with approximately 25% of environmental engineering

degrees awarded in 2019. As the FE exam is essential to civil and environmental engineering education programs, conveying the importance of licensure and FE exam preparation is often integrated into the curriculum.

In the effort to encourage students to take the FE exam and prepare for a professional career in civil engineering, many measures, programs, and policies are frequently taken by CEE departments including explicitly requiring students to take the FE to graduate, hiring licensed professional faculty, and offering an optional or required formal FE review course [3]. Numerous universities have operated FE review courses as an effective tool to improve exam participation [4], [8], [9]. While review courses are only one of the many ways to improve FE exam performance, they have also been proven to improve student confidence in course material [10]. To further encourage and support FE exam preparation, departments have offered mock FE exams, conducted a “signing day” for students to obtain signatures for the FE application, encouraged FE exam-style questions in courses, and used the FE Reference Handbook during courses [4], [5], [6]. As no single approach is definitively linked to increased scores on the FE exam, students find that dedicating time to studying and using a variety of materials is a common and effective approach [10]. The time and resources available to prepare to take the FE exam vary by program and independent student motivation. XX

Most recently, Sweeny and Sweeny [10] examined the civil engineering FE exam support by analyzing the prevalence of professional licensure among civil engineering faculty, programs that have licensure as objectives, and programs that require or encourage students to take the FE exam before graduation. They found that a majority of CE students graduate without a faculty PE role model, CE departments emphasized licensure more than other engineering disciplines, and only 19% of programs require students to take the FE exam to graduate. Although the FE exam review policies and programs have been studied, there has been no research on understanding students’ perception of FE exam preparation as impacted by department policies and programs. This background motivates the current study examining student perception of support for FE exam prep in undergraduate CEE departments. The goal is to understand how CEE departments provide support and encourage students’ participation in the FE exam. This research focuses on the motivations, department programs and policies, and study material utilized by asking the following questions:

- 1) How do CEE departments support students’ journey towards professional licensure?
- 2) What resources do students find most helpful in preparing for the FE exam?
- 3) What can CEE departments do to encourage and support students in their professional licensure endeavors?

### **CEE Website Benchmarking Methodology and Data Description**

To answer these questions, a sample of 50 civil engineering university programs were benchmarked and student perception of FE exam support was surveyed. The sample of civil engineering programs was selected based on the top 50 institutions by total bachelor’s degrees awarded in civil engineering in 2020 [11]. Data on the top 50 environmental engineering institutions was not available so only these programs were examined. Despite this limitation, civil

and environmental engineering degree programs are frequently hosted by the same department, so students often use the same department-provided resources and guidance.

Program websites were benchmarked to assess the accessibility of FE exam support on CEE department websites. This analysis does not include any in-person guidance that might have been available for students; Although this limitation means that the data might not truly reflect department communications, the analysis serves as an important indicator for the online visibility of available FE exam resources. Data was gathered by exploring CEE department websites and searching ‘licensure’, ‘PE’, ‘professional engineer’, ‘fundamentals of engineering exam’, and ‘FE Exam’ for each institution. In particular, it was noted if a program had objectives or goals mentioned licensure, sites that linked to study material, curriculum with a FE review course, and/or FE exam graduation requirement. Although collecting the number of CE faculty with professional licenses may impact students’ perception of support while preparing for the FE exam, faculty data was not included due to limitations of availability [10].

The characteristics of the 50 universities with the largest civil engineering programs are displayed in Table 1. Most of these universities (70%) are very high research activity doctoral universities [12]. The largest civil programs are located in the southeast (32%) and far west (30%). These programs awarded an average of 135 civil degrees in 2020, with a maximum of 261 and a minimum of 92 civil degrees awarded. Of the 50 sampled programs, the majority were joint civil and environmental engineering programs.

Table 1: Characteristics of Universities in Benchmarking Sample (n=50)

Characteristics of Universities in Benchmarking Sample	Combined (n=50)	% of Sample
2021 Carnegie Classification		
<i>R1 - Doctoral Universities: Very High Research Activity</i>	35	70%
<i>R2- Doctoral Universities: High Research Activity</i>	8	16%
<i>Master's Colleges &amp; Universities: Larger Programs</i>	7	14%
Region		
<i>Mid-East (DE, DC, MD, NJ, NY, PA)</i>	6	12%
<i>Great Lakes (IL, IN, MI, OH, WI)</i>	4	8%
<i>Plains (IA, KS, MN, MO, NE, ND, SD)</i>	4	8%
<i>Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV)</i>	16	32%
<i>Southwest (AZ, NM, OK, TX)</i>	4	8%
<i>Rocky Mountains (CO, ID, MT, UT, WY)</i>	1	2%
<i>Far West (AK, CA, HI, NV, OR, WA)</i>	15	30%
Civil Engineering Degrees Awarded in 2020		
<i>200 and above</i>	3	6%
<i>175 - 199</i>	7	14%
<i>150 - 174</i>	3	6%
<i>125 - 149</i>	17	34%
<i>100 - 124</i>	9	18%
<i>Under 100</i>	11	22%
CEE Department		
<i>Joint Civil and Environmental Engineering Department</i>	38	76%
<i>Separated Environmental Engineering Department</i>	5	10%
<i>Environmental Engineering Not Offered</i>	7	14%

## Web Benchmarking Results

Among the 50 civil and environmental programs benchmarked, the majority (76%) mentioned licensure in the program objectives, as seen in Table 2. This finding is larger than the 54% of CE programs that required or encourage students to take the FE exam as reported by Swenty and Swenty [10]. This difference may be due to the different sample of university types. Smaller CE programs (i.e. awarded less than 135 civil engineering degrees in 2020) mentioned licensure as an objective more than larger CE programs. Despite the goal of licensure stated, the extent to which each program mentions the FE exam on their website varied. Less than half (42%) of the benchmarked programs discussed the process of signing up for the FE exam on their CEE website. As more programs mentioned licensure as an objective than promoted the first step towards civil licensure, this data reveals a disconnect between objectives and implementation. Larger CE programs shared links to sign-up and provided a step-by-step registration process more often than smaller CE programs. Beyond civil engineering departments, most college of engineering websites also contains information about the general FE exam registration process. R1 universities provided details for general engineering students to take the FE exam (69%) more than non-R1 universities (53%) in the sample. This may be due to the additional resources available to R1 engineering colleges.

Table 2: CEE Program Website Benchmarking (n=50)

	# of Programs (% of Sample)	R1 University (n=35)	Not R1 University (n=15)	Larger CE Program * (n=21)	Not Larger CE Program (n=29)	FE Exam Required to Graduate (n=7)
Program Objective Mentions Licensure	38 (76%)	77%	73%	62%	86%	71%
CEE Discusses FE Process	21 (42%)	40%	47%	52%	34%	57%
General Engineering Discusses FE Process	32 (64%)	69%	53%	62%	66%	71%
Study Material Available	19 (38%)	34%	47%	48%	31%	43%
Review Sessions	15 (30%)	31%	27%	38%	24%	43%
Review Course in Curriculum	6 (12%)	14%	7%	14%	10%	57%
FE Exam Required to Graduate	9 (18%)	17%	20%	19%	17%	-
FE Exam Visibility						
Low	24 (48%)	46%	53%	57%	41%	29%
Medium	17 (34%)	34%	33%	0%	59%	14%
High	9 (18%)	20%	13%	43%	0%	57%

\* Larger than the sample's average number of civil engineering degrees awarded in 2020 ( $\mu=135$ )

On the same page as some FE exam registration procedures, websites linked directly to study material. This makes preparation resources easier to find for students. Study material was generally promoted through CE websites in only 38% of sampled programs. A variety of different review materials from the sample included library pages with textbook and resource access, links

to review videos, and example practice problems. Additionally, three programs offered access to self-paced online review courses; New Jersey Institute of Technology offered free access to a third-party course for current students and recent alumni. Programs that promoted study material were larger CE programs and non-R1 universities. Beyond asynchronous review material, synchronous review sessions were offered at 30% of the sampled universities. The majority of these review sessions ( $r=13$ ) were sponsored by student groups (e.g. Chi Epsilon, American Society of Civil Engineers, Tau Beta Pi) while two were produced by the department.

To ensure that students attempt the FE exam, some civil programs in the sample added an FE exam graduation requirement or required a FE exam review course in the curriculum. The semester-long review courses were zero-, one-, or three-credits. Of the six (12%) programs that offered a review course, only four programs required the course. In these required courses, students had to attempt the exam and learn the material but did not have to pass the exam to pass the course. If a student passed the exam without taking the course, they were exempt from the course requirement. Only nine (18%) of the sampled programs required students to take the FE exam before graduation. This finding is similar to a previous finding that 19% of programs clearly required students to take the FE exam in order to graduate [10]. The majority (but not all) of these programs with an exam requirement, provided steps to register for the exam and work towards licensure.

To further promote students to take the FE exam, three programs offered partial reimbursement of \$50 or \$150 to students who passed the exam. Additionally, one program offered exam reimbursement for minority students. All four programs that offered a monetary incentive were smaller programs with under 100 civil engineering degrees awarded each year.

Based on benchmarking results, programs were designated with a FE Exam Visibility category. CEE websites that listed “FE Exam” or “Professional Licensure” on a main undergraduate student menu and had a resulting page with steps to register for the exam and/or linked to review material were designated as “High FE Exam Visibility”; only 9 programs in the sample fell under this category. Websites that contained pages that mentioned the exam but were not titled “FE Exam” or “Professional Licensure” while still providing some registration instructions and/or study material were designated as “Medium FE Exam Visibility”. The largest number of sampled programs (48%) fell into the “Low FE Visibility” category, which indicated that finding any material on the FE exam on CEE websites was indirect or not existent. It is important to note this “FE Exam Visibility” rating does not include all programs or resources available to students; some departments may host an internal platform for current students and/or not explicitly describe every available resource on their website. However, it does indicate the potential perspective of prospective students and current students who are not connected to the department.

## **FE Exam Perception Survey Methodology and Data Description**

A short online survey hosted on the Qualtrics platform was developed to examine student motivation for taking the FE exam, the use of FE exam preparation resources, and potential actions for department improvement regarding FE exam support. The survey started by collecting academic status (e.g. undergrad, recent alum), engineering discipline, and status regarding the FE

exam (i.e. taken the exam, planning to take the exam, or not planning on taking the exam). Respondents who had already taken the FE exam or were planning to take the FE exam were asked additional questions on their selected timing to take the exam, process to sign up, and use of study resources available. The supporting reasoning of FE status was further explored through a series of 5-point Likert scale statements ranking the importance of different motivators and an optional text entry question. The survey concluded with 10 Likert statements to capture attitudes and potential barriers to success in the FE exam.

Convenience and snowball sampling methods were used to target civil and environmental undergraduate students and recent alumni (i.e. graduated within the last five years) in February and March 2022. Distribution was conducted by reaching out to the contact information of CEE student groups listed on department websites and asking them to circulate the survey among their board and social media; the 50 targeted schools resulted in 241 survey request emails sent out. Only eleven contacts replied that the request was granted. In response to the limited replies, the survey was also posted on online forums for civil engineers, environmental engineers, individuals studying for the FE exam, and individuals studying for the P.E. exam to gather additional general responses. Due to the non-probabilistic sampling method and resulting potential bias, data from the survey cannot be used to represent the attitudes of all university students but can be used to understand some observed trends.

Data collected from the online survey effort was cleaned by removing respondents outside of the field of civil and environmental engineering and partially incomplete responses. The resulting survey respondents (n=143) were from 51 universities across the US, including 19 of the targeted universities (r=83). Three universities (Georgia Tech, University of Texas at Austin, and University of Michigan) accounted for half of the total responses; this is likely due to personal connections during survey distribution, as seen in Table 3. The small number of survey respondents (n=143) and oversampling from three universities limit the representativeness of the survey analysis and conclusions. The majority of survey respondents (84%) attended civil undergrad programs at doctoral universities with very high volumes of research activity (R1 universities). Half of all survey respondents were CEE undergraduate recent alumni (r=70) while the other half were current students (r=71). Similarly, close to half (53%) of respondents had already taken the FE exam and almost half (45%) of respondents were planning on taking the FE exam; Only 3 respondents indicated they were not planning on taking the exam. This strong interest in taking the FE exam, although impacted by a non-response bias due to the topic of the survey, indicates the importance of the FE exam for civil engineering programs.

Table 3: Number of Survey Respondents by University Classification and Respondent Type

Survey Respondents (n = number of universities)	Total Respondents (n=143)	% of Respondents
By University		
<i>Georgia Tech</i>	34	24%
<i>University of Texas at Austin</i>	21	15%
<i>University of Michigan</i>	16	11%
<i>University of Florida</i>	6	4%
<i>University of Illinois Urbana-Champaign</i>	4	3%
<i>Other Universities (n=46)</i>	62	43%
2021 Carnegie Classification*		
<i>Doctoral Universities: Very High Research Activity (n=33)</i>	120	84%
<i>Doctoral Universities: High Research Activity (n=8)</i>	8	6%
<i>Other (n=10)</i>	11	8%
Respondent Type *		
<i>Current Undergraduate Student (n=26)</i>	72	50%
<i>Recent Undergraduate Alum (n=35)</i>	71	50%
FE Exam Status		
<i>Taken the FE Exam (n=39)</i>	76	53%
<i>Planning on Taking the FE Exam (n=21)</i>	64	45%
<i>Not Planning on Taking the FE Exam (n=1)</i>	3	2%

\* 4 respondents reported unidentifiable universities (i.e. used generic acronyms)

## FE Exam Perception Survey Results

According to the NCEES, the material on the FE exam is designed for recent graduates and students who are close to finishing an undergraduate degree [2]. Students and graduates will generally take the exam when they feel motivated, prepared, and have the available time.

Of the respondents who had taken the exam, the majority (61%) sat for the exam prior to graduating as seen in Figure 1. Respondents who took the exam while in undergrad indicated that they sat for the exam when they had time available to study; nine respondents mentioned that they timed their exam during a break while eight respondents timed the exam during a semester with a low course load. Five respondents indicated that they sat for the exam before graduation to build their resumes for upcoming job applications. Individuals who planned to take the FE exam indicated that their preferred test period was during their last semester or shortly after graduating (these individuals were able to select multiple potential time periods, so percentages do not add up to 100).

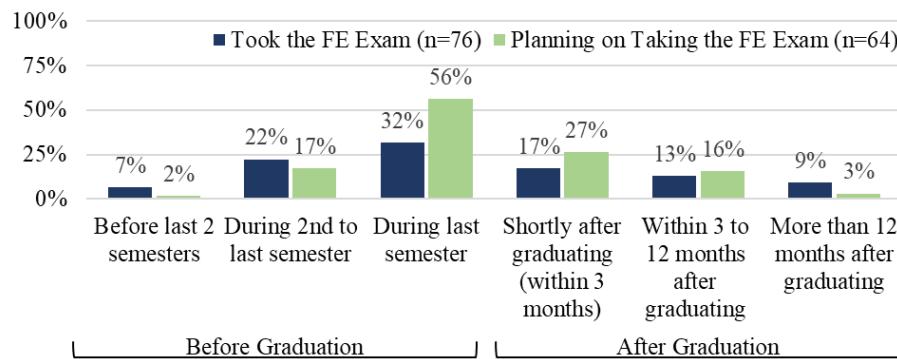


Figure 1: Timeframe When Respondents Took or Plan to Take the FE Exam

Almost half of the respondents took the FE exam after graduation (41%). The 13 respondents that indicated taking the exam within three months of graduating stated they took it when course material was still fresh in their minds and had time before starting work. Respondents who took the exam beyond three months from graduating stated the reason for taking the exam was for job advancement. These “late” FE exam takers strongly agreed with the statement “I should have taken the FE earlier”. Written-in comments in the survey revealed a similar sentiment that some individuals wish they took the FE exam earlier due to studying demands:

- “My career was never going to get less demanding as time went on so the sooner [I took the FE exam] the better.”
- “Wish I had done [the FE exam] during school. I was still in the “studying and exam-taking” mindset but wasn’t mentioned much in courses/by professors.”
- “It’s very difficult to study once you have a full-time job, and your focus should be on the PE afterward.”
- “I really should have taken [the FE exam] before graduation, but I don’t feel like CEE prioritized it at all and now I have to go back and relearn complex topics.”

Barriers may have prevented students from feeling encouraged and supported when taking the exam. The survey included an open-ended optional question asking if they observed any roadblocks to achieving their FE goals. The most frequently discussed roadblocks included the difficulty of test material content, unclear process of registration, distance to the testing facilities, lack of free study resources, and limited studying time. This roadblock regarding registration was further confirmed in the survey as most respondents (68%) shared that they had to do personal research to decide when and how to take the FE. Only 32% of respondents (n=45) who took or were planning to take the exam indicated that their department directed them to instructions on how to sign-up, prepare, and continue the next steps in the professional engineer licensing process.

To prepare for the FE exam, a plethora of study options are available including paid hard-copy books (NCEES practice exams, Lindeberg’s Practice Problems, Lindeberg’s FE Review Manual), online paid material (PESchool, PPI, School of PE), online free materials (YouTube videos), and support groups (online or on-campus). Although many resources are available, some study material may be costly and ineffective. Among respondents who had already taken the FE exam, they found the NCEES practice exam and YouTube videos to be the most helpful resources as seen in Figure 2. Students who were planning on taking the FE exam in the future similarly indicated that NCEES practice exams and YouTube videos might be the most used resource. Students who had not taken the FE exam yet expressed a larger interest in student groups’ resources and study groups than respondents who had already taken the exam.

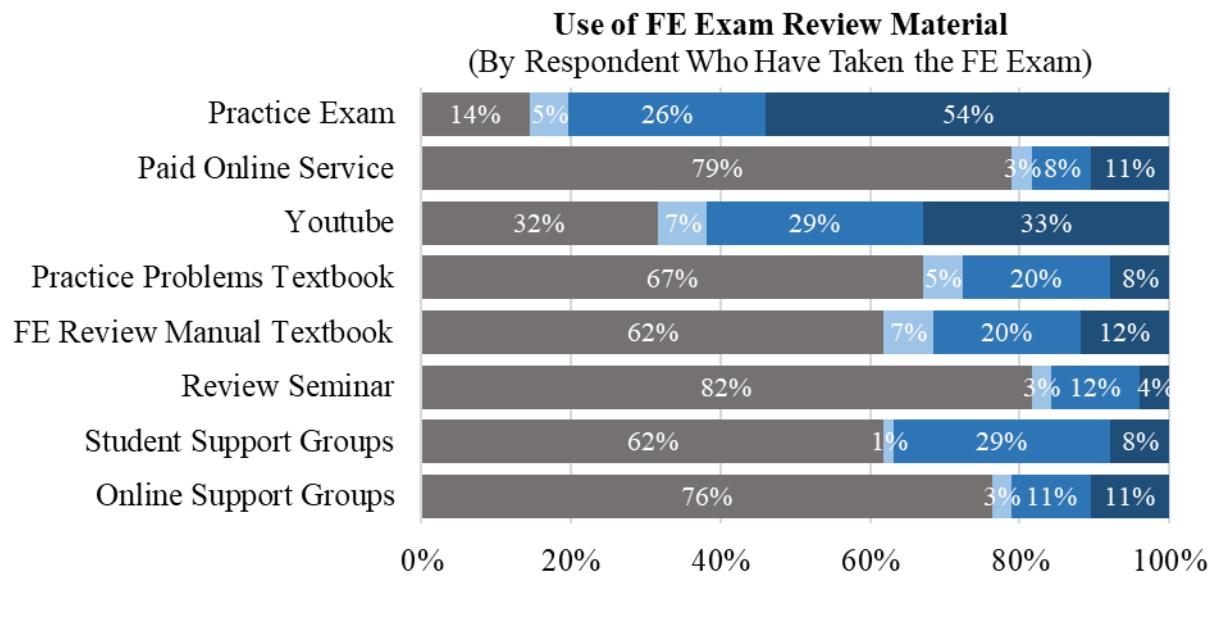


Figure 2A: Attitudes Towards Use of FE Prep Resources

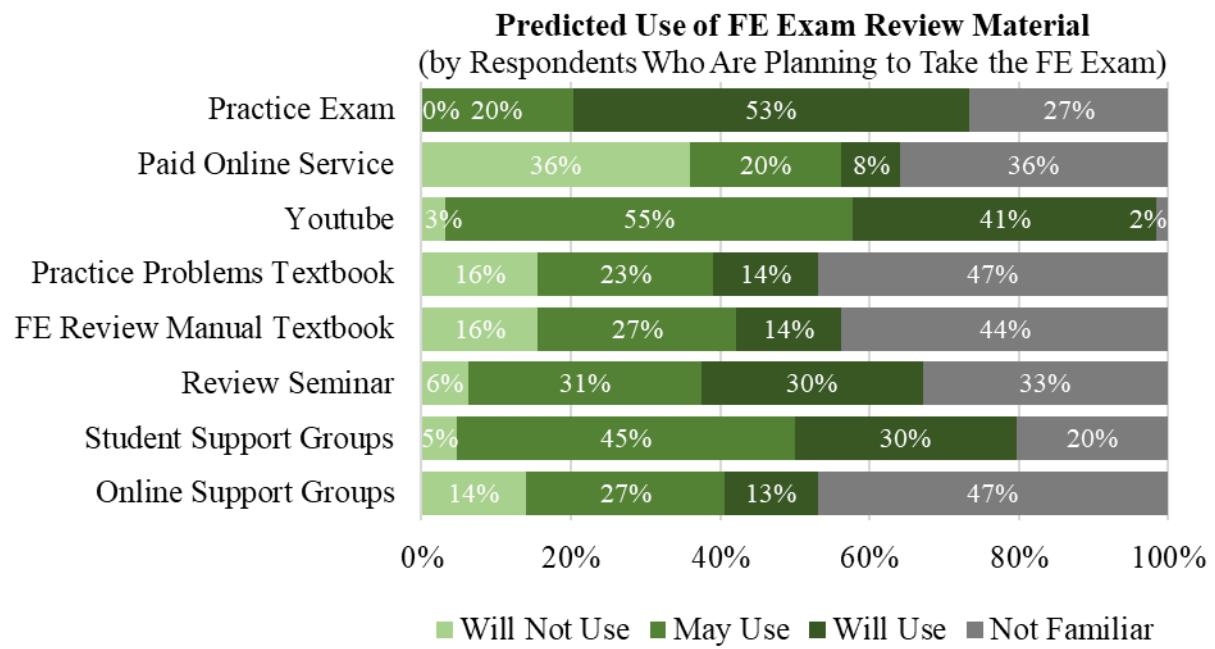


Figure 2B: Attitudes Towards Predicted Use of FE Prep Resources

Beyond the external resources, course notes can also be helpful when reviewing concepts for the FE. Respondents were asked if any courses, in particular, prepared them to take the FE. Almost half (40%) of the respondents wrote in a course name while 16% of respondents said no courses were particularly useful. Two respondents wrote in suggestions for a required FE review course; “I wish they offered an FE review class and required an attempt at taking [the exam] prior

to graduating". Although coursework was generally indicated as useful, the majority of respondents (61%) agreed with the statement that they had to learn new material beyond their coursework to prepare for the FE.

Examining the motivation behind licensure decisions indicated that career requirements, earning potential, and advice from industry were the most important factors behind licensure decisions, as seen in Table 4. These factors support the practice-aligned purpose of engineering licensure. To support this Likert-scale analysis, write-in comments provided further clarification by directly mentioning the PE as a motivational next step; "I want to become a PE and grow professionally as an engineer. Taking the FE is a very important step in doing that". These comments revealed two respondents who were not planning on taking the exam and indicated that it was because the PE wasn't required in their research field.

Table 4: Average Response to "Motivation for taking the FE exam" statements (n=143)

Motivator for taking the FE Exam	Planning to Take FE Exam (n=64)	Took FE Exam (n=76)
<i>Resume Building</i>	3.09	3.11
<i>Earning Potential</i>	3.56	3.18
<i>Refining Engineering Skills</i>	2.89	2.29
<i>Career Requirements</i>	3.57	3.59
<i>Advice from Peers</i>	2.65	2.78
<i>Advice from Industry</i>	3.15	3.18
<i>Advice from Faculty</i>	2.43	2.33

1= Not Important at All, 2 = Low Importance, 3 = Important, 4 = Very Important

Advice from peers was generally valued as a higher motivation for deciding on professional licensure decisions than advice from faculty, advice from faculty was the lowest-ranked motivation. Respondents had the option to name faculty who motivated them to pursue professional licensure but only ten faculty members were named. Of these ten faculty members listed, eight of them had their PE and the other two were department chairs. This indicates the importance of having licensed faculty on staff to encourage students in taking the FE.

Beyond the seven motivating factors represented in Table 4, four respondents clarified that a motivating factor was that they were required to take the FE exam to graduate. Of these four respondents, three agreed or strongly agreed with the statement that students should be required to take the FE before they graduate. Almost half of the survey respondents agreed that the FE exam should be required for students to graduate as seen in Table 5. Requiring the FE exam to graduate is nuanced and should depend on the goals of the institution and support for students.

Respondents who reached the end of the online survey were asked a series of general attitude statements about the FE Exam as seen in Table 5. Attitudinal statements indicate that while a majority of students felt encouraged by their college and supported by peers to take the FE exam, only a smaller proportion indicated that their department provided sufficient support. This indicates that the student peer environment plays an important role in the FE exam. Almost half (47%) of respondents who had already taken the FE exam felt like they were not provided with

sufficient access to prep materials and more than half (63%) had to learn new material to prepare. This may suggest a large time and effort burden on students as they search for additional study materials and learn exam content outside of courses. Survey respondents also indicated personal effort beyond courses to understand the licensure process; less than 20% of respondents had licensure explained clearly in some courses. Only a minority of respondents (24%) who had already taken the exam wished they took the FE exam earlier but respondents who were planning to take the exam displayed a slightly larger agreement (45%) with this statement. Almost all survey respondents agreed that taking the FE exam was important for their career as civil or environmental engineers. This result is likely biased as there was insufficient data from survey respondents who were not planning on taking the FE exam. Further work should include increased sample sizes from a variety of universities to improve data accuracy and explore additional impacts on student perception by department features.

Table 5: Percentage of Respondents that Agreed or Strongly Agreed to Attitudinal Statements (n=143)

Percentage Respondents that Agreed or Strongly Agreed to Attitudinal Statements	Planning to Take FE Exam (n=64)	Took FE Exam (n=76)
I felt encouraged by my college to take the FE Exam.	83%	74%
I had sufficient support from my college to take the FE Exam.	63%	50%
I felt supported by my peers to take the FE Exam.	72%	93%
My college did not provide sufficient access to prep materials.	58%	47%
I had to learn new material beyond my courses to prepare for the FE.	56%	63%
My college directed me to instructions on how to sign-up, prepare, and next steps in the professional engineer licensing process.	45%	21%
I had to do my own research to deciding when and how to take the FE.	66%	70%
The professional engineer licensing process was mentioned in some courses.	44%	34%
The professional engineer licensing process was explained clearly in some courses.	11%	17%
I should have taken the FE Exam earlier.	45%	24%
Students should be required to take the FE before they graduate.	47%	46%
Taking the FE is important for my career.	91%	95%

The survey concluded with an open-ended question for any additional comments or suggested improvements. Suggestions included clarification of the exam registration process, the addition of an exam review course for credit, and discounts on material and registration. Noteworthy student recommendations are as follows:

- “Providing a list of professors with their PE who would be willing to sign [FE exam registration forms] would have been helpful!”
- “It would be nice to offer [an FE review] as a 1 credit class rather than just encourage students to take it during college. It's hard to study for an exam when you have a full course load and work full time.”

- “[A review course that also] explains the exam process. It is so intimidating walking in when they are scanning your handprints and whatnot. Or session that gives you tips on how to study and take the test.”
- “Having more details mentioned in capstone courses like how to register, etc...[for the FE exam]. The [FE] review course was expensive and not CE specific, so it did not seem worth it to me”
- “I would like them to offer discounts for students [to register for the FE exam]. It’s an expensive exam but an important one. One motivator would be if they could offer a discount for us.”

## Conclusions and Recommendations

Examining 50 top CEE department websites and corresponding student attitudes towards professional licensure revealed potential gaps in department support for students preparing to take the FE exam and working towards a professional career in civil and environmental engineering. Despite most programs in the benchmarking sample stating licensure as an objective, only a minority of CEE departments supported students’ journey towards professional licensure by sharing resources to register and study for the FE exam on their website. Although this study did not examine all resources available to students, it does capture visibility of FE exam support on department websites which is often the perception from prospective students and current students who may not be well connected to department resources. Future work to fully assess FE exam support should involve reaching out to each department to examine internal resources.

The support perceived by students when preparing for the FE exam was further assessed by an online survey. The largest roadblocks identified by the survey included the unclear process of registration, lack of free study resources, and limited studying time for students. A majority of respondents indicated that their department did not share clear instructions on the licensure process and many respondents identified this key issue as a barrier to success. Student indicated that the professional engineer licensing process was mentioned in only a few courses which might explain why the advice from peers was a stronger motivator for respondents to take the FE exam than advice from faculty. The main motivation for taking the FE exam for most respondents was related to the importance of licensure in the field of civil and environmental engineering. Many survey respondents strategically timed when they took the FE exam to provide a competitive hiring advantage to advance their careers. As lack of study time was a major constraint for all survey respondents, some individuals took the exam within 3-months of graduating: the period when they had free time before starting a career and when exam content is still recent. Individuals who took the exam more than 3 months after graduation wished they would have taken the exam earlier due to lack of resources and time post-graduation. Survey respondents expressed the need for a credited FE review course to relieve the burden of identifying and accessing study materials, self-teaching exam content not covered in courses, and reserving studying time on top of large course loads. The survey further revealed that while students felt generally encouraged to take the FE exam by their department, they did not perceive that they had sufficient access to exam preparation material and knowledge of the exam process. Study materials for the FE exam (e.g., library pages with textbook and resource access, links to review videos, and example practice problems) were accessible on a minority of benchmarked program websites. This lack of visible department-provided study material via a department website might be the reason many students rely on external study

materials; most survey respondents found Youtube videos and the NCEES practice exam to be the most helpful resources. Future work should expand the survey sample size to capture FE exam perception of students and recent alum from all 50 of the benchmarked CEE departments.

To encourage students to take the FE Exam, CEE departments should emphasize to current students the benefits of taking the exam while still in school (e.g., fresh memory of course material and available resources). Four-year plan documents could mention the FE Exam even if it is not required to graduate. CEE programs should consider offering or requiring a FE review course in the curriculum. Further recommendations include FE-style questions in technical courses and discussions of the licensure process in capstone courses. Understanding that the timeline of taking the FE exam depends on each individual's time availability to study, departments should also facilitate and support FE exam prep resources for recent alumni. To enhance exam pass rates and reduce the student financial burden, departments may consider developing a scholarship or reimbursement policy for a portion of the exam registration costs if a student passes the exam while in the program. A low-cost and low-effort recommendation to improve FE exam support for undergraduate students involves CEE department websites providing clear instructions on the FE / PE process, how to submit required forms, and list licensed faculty that can sign forms. Access to this useful information should be visible on multiple CEE website pathways (e.g. prospective, current, and graduate students) so first-years, current students, and alums can make informed decisions. Departments should consider hosting a yearly information session on the licensure process to connect students to resources and a study community.

If promoting licensure is truly a priority for CEE programs, they should examine and realign their website and curriculum to match their priorities. The FE / PE process should be clearly discussed throughout the curriculum; from the introduction of licensure in beginning courses to FE exam-type problems integrated into coursework on tested topics. Departments should consider adding a required 1-credit FE review course to build a peer study network, review exam concepts, and share test-taking skills. Although there is a wide variety of prep resources, departments should continue to work towards providing more updated, free, and accessible study material. CEE department and university libraries should rent free review textbooks and practice problems for student use. Student organizations that build and support the undergraduate community should be funded or celebrated for their dedication to their peers. Finally, departments should continue to support and add licensed faculty on staff to mentor students towards licensure.

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