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A Case Study on Professional Engineering Licensure Preparation in an Interdisciplinary Engineering Design Capstone Course

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Abstract

This case study shares the approach one interdisciplinary engineering program used to increase the engagement with professional engineering licensure. Data comes from library usage of Fundamentals of Engineering (FE) preparation materials, information on timing within the academic year for students to register and sit the exam, as well as course assignments related to FE exam preparation. This model from the Thayer School of Engineering at Dartmouth College demonstrates a replicable approach to supporting students in bridging the gap between engineering education and professional licensure to guide the future of engineering's workforce. Exam registration is funded through departmental budget and applied directly via NCEES voucher, requiring no out-of-pocket payment from students. The data suggests this style of intervention can increase the percentage of students participating in engineering licensure through registration to sit the FE exam (157.1% increase) with no statistically significant change to the percent of students passing the FE (pass rate of 96.0% pre-intervention, 94.1% post-intervention, p=0.615). While most Dartmouth students sit the Other Disciplines FE exam, elements of this intervention are applicable across disciplines for engineering educators interested in increasing participation in licensure among engineering graduates, including civil.

Keywords: licensure, fundamentals of engineering, capstone, workforce development

FE preparation in an interdisciplinary capstone course

At the Thayer School of Engineering at Dartmouth College, the interdisciplinary capstone course spans two 10-week terms and welcomes students from three degree programs: Bachelor of Arts (AB), Bachelors of Engineering (BE, ABET accredited) and Masters of Engineering (MEng). The capstone design experience is centered on a project completed by teams of four to six students in partnership with an industry or nonprofit organization. The industry-based capstone grounds the students' learning in professional settings and aims to provide them early access to the professional communities they will join after graduation.

In the first term of the course as part of their professional development within the capstone, students view an asynchronous lecture on the licensure process and as their culminating professional development assignment take a nine question simulated FE exam on the topics of safety, engineering ethics, and engineering economics. In the second term of the capstone course, students receive a live lecture on the licensure process detailing the requirements and the motivation to become licensed. Students may sign up for the FE exam and have it paid for by Dartmouth using an NCEES voucher (automatically applied to their NCEES account) to fulfill part of their professionalism assignment in the second term of the capstone design course. The

professionalism components of the capstone course are outlined in Figure 1. The professional development (PD) sequence undergirds the team-based design project completed over two academic terms and includes assignments on safety (PD3), ethics (PD4), engineering economics (PD5), and a simulated FE practice exam (PD7); these assignments are described in detail in our 2025 ASEE conference paper [1].

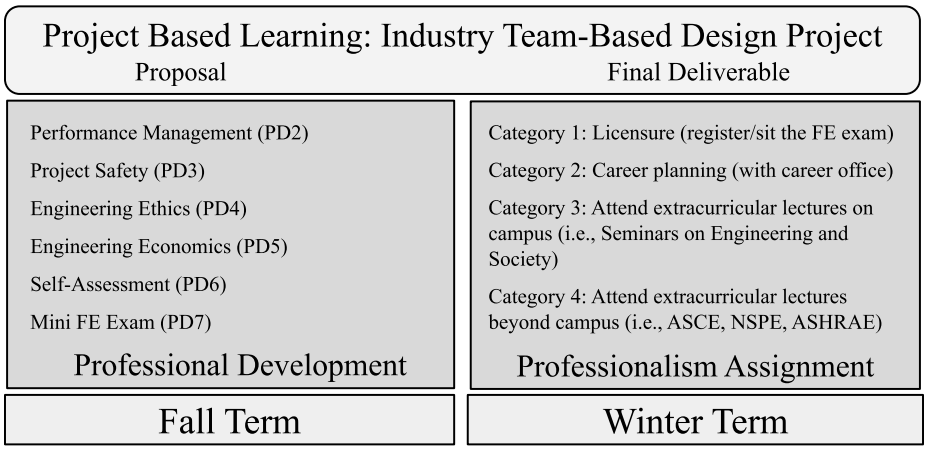

Figure 1: The professional development sequence for Dartmouth Engineering's two-term capstone design course.

The FE exam is a national exam that initiates the process of engineering licensure; it is a key component in the workforce pipeline of licensed professional engineers. To become a licensed Professional Engineer (PE), engineers must take the FE exam and gain four years of experience as defined by each state, before they can sit the PE exam. In the United States, the National Council of Examiners for Engineering and Surveying (NCEES) is the only organization that controls the series of exams required to become a professional engineer.

Dartmouth encourages its engineering graduates to consider the path of licensure during the capstone course through guest lectures from licensed professional engineers, practice exam questions as homework assignments (PD7), and offsetting costs by paying for any student in the engineering program to register for the exam (Professionalism Assignment, Category 1). Students have 6 months from receipt of a test payment voucher to the deadline to register for their exam, and the student must sit the exam within 12 months of registering. For most students this means that they have an 18 month window in which to take the exam free of registration cost. This window of opportunity results in a lag of exam results and decouples graduation date from examination date. It is also noted that while students at Dartmouth previously had the ability to be reimbursed for a passing result on the exam, the voucher system was implemented in 2022, allowing students to have Dartmouth pay for the exam upfront without a pass condition.

The FE exam moved from paper to computer based testing in 2014, and the test ecosystem has continued to evolve [2]. Dartmouth's engineering library has long provided access to prep materials for these exams. Beginning in 2022, students were given checkout access to print

versions of the 2020 NCEES FE Practice Exams (including relevant errata) for a two-week loan. The following practice exam subjects are available for checkout at the Dartmouth engineering library: “FE Other Disciplines” (5 copies), “FE Electrical and Computer Engineering” (2 copies) and “FE Mechanical” (2 copies). In addition, the library provides print and online access to Lindeburg’s PPI FE Review Manual.

This case study outlines the methods used at Dartmouth to encourage licensure participation through registration and completion of the FE exam. The results are limited in generalizability, and the intervention as described here reflects a single institution's context. The data for this analysis comes from:

1. The number of NCEES FE Exam vouchers provided by Dartmouth
2. The number of total passing results for students affiliated with Dartmouth as provided by NCEES institution reports
3. The total circulation statistics for print practice exams, calendar years 2022 through 2025
4. The total number of students per year graduating from Dartmouth’s engineering program as indicated by the registrar

In the first three academic years studied, use of the FE Practice Exams were relatively low (18 checkouts), but following the increased efforts in the capstone course to encourage students to sit the FE exam, use in academic year 2024-2025 grew to 54 checkouts for FE prep materials, with 41 checkouts for FE practice exams as illustrated in Figure 2.

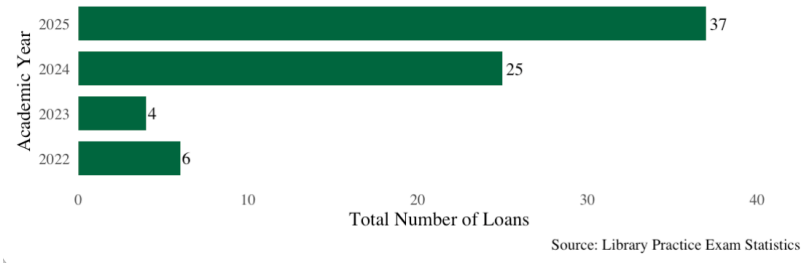

Figure 2: Number of checkouts of FE Practice Exams from Dartmouth Libraries, 2022-2025.

We estimate the cost per student of this intervention to be just over the cost of the exam registration fee once we normalize the prep material cost over the number of graduating students who were offered the practice exams since purchase in 2020, as outlined in Table 1. It is noted that the print practice exams are no longer available from NCEES.

Table 1: Cost per student of this intervention since purchase of the practice exams and prep books in 2020.

Item	Normalized Cost (USD/Grad)
NCEES Practice Exam (Print) and Prep Book (Print)	$0.92
FE Registration	$225.00
Total Cost (Per Student)	**$225.92**

Since the FE Civil represents 45.8% of the FE exams taken in 2025, we compared the content of the FE Civil to the FE Other Disciplines exam [3]. As of the July 2020 computer-based exam specifications, both the FE Civil and FE Other Disciplines exams consist of 110 questions across 14 knowledge categories, of which 8 are shared between the two exams, as shown in Table 2 [4], [5]. These topics also correspond directly to outcomes in the Engineering Fundamentals and Professional categories of the Civil Engineering Body of Knowledge, Third Edition (CEBOK3), including safety, engineering economics, ethical responsibilities, and professional responsibilities [6]. The six FE Civil-specific categories not covered by the FE Other Disciplines exam — Surveying; Water Resources and Environmental Engineering; Structural Engineering; Geotechnical Engineering; Transportation Engineering; and Construction Engineering — align with the core discipline areas of the PE Civil exam, reflecting the curricular foundation that civil engineering programs already provide prior to the capstone [7]. The capstone intervention described here addressed safety, ethics, engineering economics, and FE exam readiness (Figure 1, PD3–PD5, PD7), topics common to both exams, and did not depend on content unique to either discipline. EAC-ABET accredited civil engineering programs should therefore be able to implement this intervention directly, with the option to adapt the FE practice exam assignment (PD7) to include civil-specific question categories.

Table 2: Knowledge categories common to both the FE Civil and FE Other Disciplines exams.

Knowledge Category	FE Civil No. of Questions	FE Other Disciplines No. of Questions
Mathematics and Statistics	8–12	8–12
Ethics and Professional Practice	4–6	5–8
Engineering Economics	5–8	6–9
Statics	8–12	9–14
Dynamics	4–6	9–14
Mechanics of Materials	7–11	9–14
Materials	5–8	6–9
Fluid Mechanics	6–9	12–18

With improved outreach within the capstone course in this intervention, the number of students sitting the exam increased by 157.1% from the period pre-intervention (2015 - 2021) to the period the intervention was in place (2022 - 2025) as seen in Figure 3. A two-sample test for equality of proportions with continuity correction confirmed that despite the surge in participation, the aggregate passing rate remained stable, showing no statistically significant change between the pre- and post-intervention cohorts (96.0% vs 94.1%, p = 0.615).

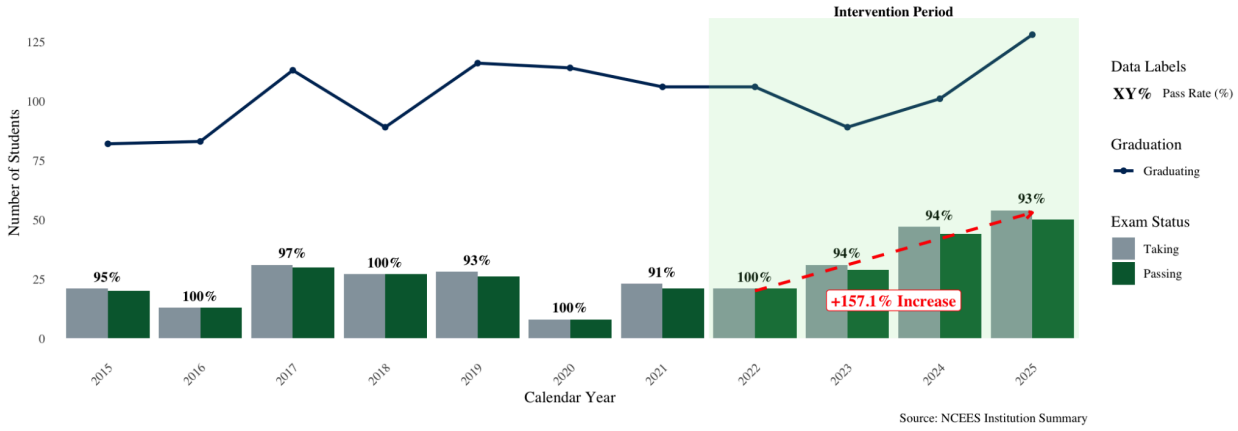

Figure 3: Results of Dartmouth students who take and pass the FE exam, before and after the intervention described in this paper.

As the format of the study material evolves, print study materials are being phased out. Since the FE exam is held in a computer-based testing center, it makes sense that study materials are trending toward digital-only formats. In June 2024, NCEES transitioned their FE prep materials to interactive, online-only practice exams that are available only through an individual's NCEES account and no longer sell print or PDF copies [8]. There are two online-only versions available for each FE exam discipline, each for $50. The transition to interactive, online materials creates future challenges for library support of study material and possibly student access, even if the cost is relatively low. The print practice exams may lose their future relevance to the exam as questions evolve and they can no longer be replaced. At this time, there is not an option for libraries to provide access to these interactive practice exams, though a future option would be welcomed by engineering librarians.

Despite this evolving landscape, the structural elements of this intervention, including capstone-integrated licensure instruction, cost elimination via departmental vouchers, and a practice exam assignment, remain replicable at low cost and without dependency on any particular study material format.

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