

On-Line FE Exam Review Course Results in Effective Instructional Model

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Abstract

A 2020 redesign of “Engineering Practice and Professional Licensure,” the Citadel’s review course designed to prepare students to pass the National Council of Examiners for Engineering and Surveying (NCEES) Fundamentals of Engineering – Civil Exam, resulted in a considerable increase in pass rates over 2019. Key to growth in the pass rate was a partnership with a widely respected computer-based testing (CBT) provider, PPE Headquarters out of Canada. This company’s platform provided students the opportunity to individualize their curriculum and to access on-line study questions, preparation materials, and solutions, which reference relevant pages in the Fundamentals of Engineering Reference Handbook (FERH). The duration of each class, access to a full-time professor, and time available in the lab did not change. Weekly, student progress was celebrated publicly when the professor posted (anonymously) time spent on modules, the number of tests completed, and the accuracy. “Student experts,” who were available throughout the class, answered questions and provided peer guidance. At the end of the semester the student pass rate had measurably improved.

Keywords

Technology, Peer Teaching, FE Exam, Assessment, FE Pass Rate

Introduction

The National Council of Examiners for Engineering and Surveying (NCEES) writes and administers the Fundamentals of Engineering - Civil Exam (FE), a 110-question, six-hour, computer-based exam. The FE is the first step to becoming a licensed professional engineer (PE). PE licensure has additional examination, education, and experience requirements that vary by state. Many private sector companies and government employers require a civil engineer to obtain their PE.

The FE covers subjects studied in a typical engineering program. For civil engineering subjects include mathematics and statistics, ethics and professional practice, engineering economics, mechanics of materials, statics, dynamics, fluids, materials, surveying, water resources and environmental engineering, structural engineering, geotechnical engineering, transportation engineering, and construction engineering.¹ At the Citadel, students take the FE exam during their final year of study as a requirement for graduation.

To improve the student’s pass rates, the Citadel’s civil engineering faculty created a 1-credit hour, 2-contact hour, FE review course in 2018 for the Fall Semester of the students’ final year.

Passing rates improved after implementation. FE preparation courses are part of the Citadel's required curriculum, designed to give confidence to graduating seniors and to improve their ability to pass the exam. According to NCEES, in the past 6 months, 70% of 6,049 examinees passed the FE Civil exam.² Examinees included those who took the FE for the first time, those who attended AC/ABET-accredited engineering programs, and those who took the FE exam within 12 months of graduation.

To further improve passing rates, the Citadel partnered with a computer-based testing (CBT) PPE Headquarters in 2020. The Citadel's FE pass rate increased from 2019 and can be attributed, in large part, to the partnership with the CBT platform provider. The adoption of an online platform allows for the collection of student engagement indicators and macroscopic insights that educators don't normally get. Currently the two-hour once a week instruction is divided into parts. First, the instructor introduces the students to one of the FE subjects in a traditional setting. Second, the students engage with the platform to work on practice problems where they can ask professors or "student experts" questions to improve their understanding of the material. Finally, instructors provide periodic feedback and public recognition of successful student performance.

Partnership with CBT Platform, PPE Headquarters

In late 2019, through continuous improvement, this class was transitioned to a student-centered approach, focused on a single goal: improving the FE exam pass rate. This led to a partnership with PPE Headquarters, a respected CBT provider, that delivers an individualized student experience with immediate performance feedback. Students access subject modules, consisting of exam questions with thorough solutions, that match the NCEES exam syllabus. Solutions that reference the FERH, and a timed environment while working practice problems, prepares students for the actual NCEES CBT experience.

Course materials and an accompanying individual log-in were provided to all students. At the beginning of the course, students completed an assessment test, which highlighted their areas of strength and deficiency, and provided a baseline for an individual study plan. The weekly, 110-minute class included a hybrid of personalized, one-on-one training, along with a structured, professor-led review of the 14 modules.

The collection of student performance analytics, from both inside and outside the classroom, include the following: questions attempted, answer accuracy, and time invested. These analytics help assess the student's subject mastery and guide the student's study schedule. Combining the student analytics allows for a student-to-class comparison, and when combined with historic pass/fail results, establishes the baseline performance parameters to pass the FE. The course is now less a professor-centered review of equations and example problems and more of a data-driven, student-centered, review that has improved their FE exam pass rate.

Immersion Training & Peer Teaching

The course syllabus is aligned with the NCEES syllabus ensuring that while learning is individualized and customized, it is also highly organized and predictable. Balancing the highly independent learning style of a CBT platform with a traditional classroom design ensures that all

students – regardless of their initial concept mastery levels – have an opportunity to refresh their knowledge to improve their chance of passing the FE Exam.

Within the traditional classroom setting, each student receives a weekly assignment designed by the professor and kept in the student's binder. Each assignment is accompanied with printouts of sections they have reviewed, handouts of formulas and equations, and copies of relevant pages from the FERH. The professor assists "student expert teachers" who upload their solutions to a discussion board on a learning management system and leads the class exercises bringing in some of the benefits of peer instruction³. Students manageably create a collaborative resource of solutions where "expert" students are empowered to support the learning of their peers.

Of the 110 minutes available in each class period, approximately 45 minutes is spent in a traditional teaching setting while the other 65 minutes are spent in the computer lab. This blend of individual learning and classroom problem-solving reinforces fundamental concepts required to pass the FE Exam and simulates the NCEES CBT environment. Watching problems solved by their peers increases student attention and participation.

Measurement and Management

Equally important to the year-over-year improvement in student pass rates is providing students with a real-time assessment of their subject mastery. Access to a platform which tracks student engagement, combined with historical pass/fail results, allows evidence-based decision-making about their probability to pass. Or, in other words, the student is continually aware of how likely they are to pass the FE exam based on their current understanding of the concepts and their study habits.

Students' weekly "Accuracy" (questions correct /questions attempted) and "Time Spent" results are calculated per module. Then, the professor calculates the "future module Accuracy required" for each student to achieve at least 60% overall Accuracy, a metric internally correlated with a high probability to pass the FE exam. This data provides both encouragement and opportunity for mid-course correction. Students whose scores do not average 60% receive an encouraging email, highlighting where to focus their personal study time. Each week, the top three students are recognized for their "Accuracy" and "Time Spent" scores. This public recognition promotes student-to-class comparisons and rewards both mastery and dedication to studying.

Future Work

The authors intend to publish a fuller work expanding on the quantitative measurements of student success achieved by the FE review course.

Conclusion

Partnering with a respected CBT provider delivers a personalized, subject-matter review that allows students to focus on those areas in which improvement is required to receive a passing score on the FE Exam. Peer teaching with "student experts" changes the instructor's role to that of "lead problem solver" rather than that of content expert in all 14 Civil Engineering sections of the NCEES syllabus. The weekly in-class instruction, peer teaching, encouragement, and mid-course review provide a structured environment that encourages engagement with the material. The outcome was an improved passing rate for the FE Exam.

References

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