

WEB-BASED AUTOMATED ASSESSMENT FOR ABET PROGRAMS

Lloyd R. Heinze¹, James M. Gregory², and Donald J. Bagert³

Abstract $\frac{3}{4}$ The College of Engineering has developed several innovative tools to automating the processes of assessment and evaluation of outcomes of university, college of engineering and individual ABET engineering programs. The authors develop algorithms and mathematical models, then directly write computer code or work with software engineering students to develop the software. This same team provides workshops to demonstrate to students, advisors and faculty the value and use of these web-based tools. Quantitative information is automatically plotted and users most recent results displayed relative to historical trends. One example is the Texas Tech “Mock FE” administered by the college to senior students two weeks prior to the Fundamentals of Engineering (FE) Exam. An individual’s results of this four-hour test are available to each student and plotted relative to historical trends thus allowing each student to predict his/her performance on the FE relative to each subject.

Index Terms $\frac{3}{4}$ ABET Assessment, Fundamentals Exam, SAT, Web based.

INTRODUCTION

High quality of programs is one goal for the College of Engineering at Texas Tech University. In addition to having high quality in the areas of our education objectives, we also desire to have breadth in engineering knowledge and skills. While we acknowledge that we do not live in a perfect world, we desire that a high percentage of our students meet our quality standards. Quality goals imply assessment: measurement and comparison of quality indicators to standard or target values. We have elected to use the Fundamentals of Engineering (FE) Exam as one of our measurement tools. The FE Exam is not designed to measure complete knowledge and skills needed to be an engineer. For example, it does not measure the essential skills of oral and written communications. The FE does, however, measure basic knowledge and skills in math, chemistry, physics, and engineering. Because it is given nationally, it is a good index of how our students do in comparison to other students in our state and across the nation.

There are several advantages for using the FE Exam as an assessment tool. One, it has a historical base. Two, it is

administered nationally. Three, a summary of performance in subject area is provided. Finally, there is no additional cost to a college or department—many students take the exam as part of the process to become a professional engineer. There is one disadvantage—the individual’s results are pass or fail instead of a numerical score. We use a Mock FE Exam administered locally in the college to obtain numerical values. We believe that both processes together provide a useful assessment tool.

OBJECTIVE

The primary objective of this paper is to report how the College of Engineering uses the FE exam as a nationally normalized assessment tool. Special emphasis will be placed on petroleum engineering as an example program within the College of Engineering. True assessment is not complete or at least has little value unless results from the assessment are fed back into the system to maintain or improve quality. We, therefore, have included comments about how the Petroleum Engineering Department has or intends to use measured outcomes. Because quality of incoming students may affect the quality of the output measures, we have included SAT data as introductory background information. The ultimate goal was to determine if engineering students at Texas Tech University are performing at or above the average of other engineering students on a national scale.

PROCEDURE

Our procedure is simple. The Dean’s Office receives a report of who passed or failed and a summary of performance in the major topic areas on the exam. These results occur twice each year. Starting in fall of 1999, the College of Engineering also administers a one-half-day Mock FE Exam two weeks prior to the actual FE Exam. The format of both exams is similar. Students have an opportunity to self assess their probable performance on the FE with the Mock FE. If they detect a weak area of knowledge and skills, they can review in these areas. Students are now required to take the Mock FE as part of our assessment plan. While a performance level is not required at this time for graduation, the process seems to promote a professional engineering culture. We have a high percentage

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of our graduating class who take the FE Exam. Taking the Mock FE with feedback to the students has also encouraged students to take the FE Exam instead of not showing up for the FE Exam. The results from the FE Exam have been analyzed as a function of time for this paper.

The College of Engineering typically has about 70 percent of graduates complete the FE Exam and usually 90 percent or better passage rate. The Mock FE Exam provides a performance score to accompany the passage rate on the FE. The College has developed web-based software tools to automate the assessment and reporting process.

RESULTS

Comparisons are made between departments at TTU, College of Engineering, Texas, and the nation. The FE allows tracking (comparison and contrasting) of skill levels in the applied sciences of Chemistry, Computer Science, Mathematics, and Physics--all sciences critical to the successful petroleum engineer. The Geosciences, which are critical to petroleum engineering, are not measured by the FE exam; therefore a different assessment tool is used. The engineering subjects measured by the FE exam include: Dynamics, Electrical Circuits, Engineering Economics, Ethics, Fluid Mechanics, Material Science, Mechanics of Materials, Statics, and Thermo. Adjustments to the curriculum and individual courses over the last nine years and their cause/effect relationships on the FE are highlighted in this paper.

Figures 1 and 2 show the relationship between the Texas Tech University (TTU) administered Mock FE and the FE. Students obtain their individual results by subject and total score and are able to use Figures 1 and 2 to predict their potential success on the FE. They also can determine which subjects they need to study for the FE, which follows the Mock FE in two weeks.

BACKGROUND RESULTS

TTU, as a state-assisted institution, recognizes its responsibility to provide excellent education opportunities for its students. Since experience indicates that prospective students with poor academic records have little chance of successfully completing petroleum engineering degrees at TTU, class rank in high school and SAT-I and ACT scores are used to help predict potential academic performance. Other factors that could predict success in petroleum engineering at TTU are also considered. For comparison purposes the average composite SAT scores for incoming freshman from 1993 – 2001 is plotted in Figure 3. The University, College of Engineering and Engineering Departments raised the minimum admission standards from 1995 to 1996, which resulted in a 70 to 90 point increase. The average composite ACT scores for incoming freshman from 1993 – 2001 shows a like improvement.

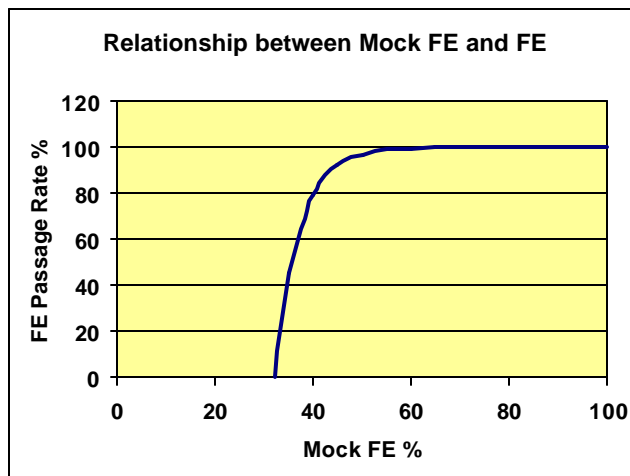


FIGURE 1

FE PASSAGE RATE

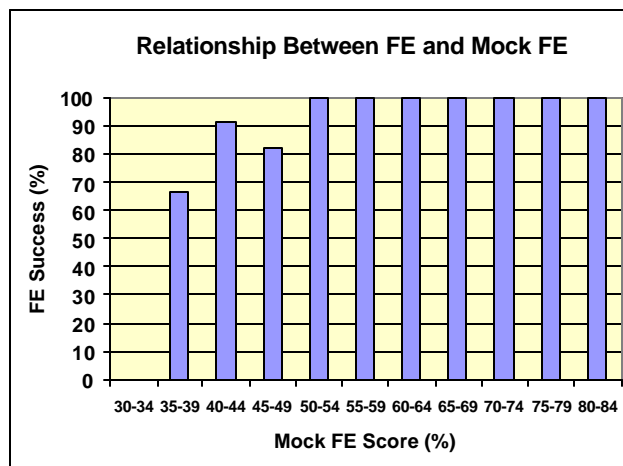


FIGURE 2

FE SUCCESS

RESULTS ON FE

The FE exam subject distribution was changed between 1996 and 1997. Questions in the subject of computers were reported separately; additionally discipline specific afternoon sessions were introduced.

Figure 4 is a plot of Fundamentals of Engineering (FE) pass rate from 1993 – 2001. The solid red, blue and yellow curves are Petroleum Engineering at respectively TTU, the State of Texas, and in the nation. The dashed red, blue and yellow curves are engineering at respectively TTU, the State of Texas and in the nation. (The same legend will be used to simplify discussion on most of the next curves) Over the last nine years the Department of Petroleum Engineering at TTU has been the top performer except during the 1996-1998 period. From 1993 to 1995.5 department students self selected taking the FE and their pass rate was almost perfect.

In 1996 the faculty strongly encouraged students to take the test during their senior year. The pass rate slipped to 60%. Over the last five years, the department conducted progressively improved review classes and the pass rate has average 90% the last 2.5 years. Also of note over the last five years is that the scores in the fall exam are lower than the spring exam. There is an extra month to prepare for the exam in the spring over the fall.

Figure 5 shows in red the same FE pass rate for TTU Petroleum Engineering as in Figure 4. The blue curve (and dotted blue linear curve fit) indicate the number of TTU Petroleum Engineering Students passing the FE divided by the number of students graduating that half year. The effects of faculty encouragement to take and pass the FE and the review classes can be seen. The linear curve fit shows an improvement from 22% to 100% over nine years. The department target is to have 95% of its students graduating to pass the FE.

Figure 6 shows Chemistry scores have improved from 45% to 65% from 1993 to 2001. TTU petroleum engineers' performance in chemistry is slightly ahead of its competitors in Texas and the nation. During this time frame the College of Engineering, during freshman orientation, piloted a chemistry placement test. Dr. Heinze, the petroleum engineering undergraduate advisor, played a key role in both the chemistry and math assessment pilot tests. As a result students are more successful in freshman chemistry (C or better grade has improved from 35% to 77%). The chemistry department has made placement, as determined by the assessment test, mandatory for the entire university and agreed to administer the test removing the burden from the college of engineering. At TTU in the College of Engineering, only the departments of Civil, Chemical, Industrial and Petroleum Engineering require more than the first semester of Chemistry. Figure 6, a plot of all TTU FE exam participants Chemistry results, indicates improvement from 47% to 65% over the last nine years. The curriculum committee recommended dropping the second Chemistry, as only thermodynamics are needed from CHEM 1308, from future Petroleum Engineering requirements and adding Petroleum Thermo to PETR 2302 (Properties of Petroleum Fluids). Comparing FE exam Chemistry scores over the next few years will show the results of this action.

CONCLUSIONS

At least four conclusions can be made at this time from these results. First, student performance on the FE exam appears to be a reasonable and useful measure of engineering knowledge and skills. Second, we conclude that Texas Tech students have above average performance and that our engineering education system is sound. Third, we noticed

that the trends for our students tend to follow the trends of the nation, which probably reflects variations of tests questions each year. Finally, we have observed increases in input quality of students as measured by SAT and ACT scores and we have seen an increase in our performance on the FE exam over time. The shape of these trend lines is not necessarily related.

ACKNOWLEDGMENT

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Dr. Gregory has served as Associate Dean for Undergraduate Studies in the College of Engineering at Texas Tech University for seven years. He has spent over a decade in the research and development of tools to improve engineering education and student success in college. Dr. Gregory is a registered Professional Engineer in Texas.

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REFERENCES

Heinze, Lloyd R.; Lawal, Akanni S.; Gregory, James M.; "Continuous Assessment and Continuous Improvement Tool," the ASEE Gulf-Southwest Section 2002 Annual Conference, U of Louisiana at Lafayette March 2002.

Heinze, Lloyd R.; Gregory, James M.; Bagert, Donald J.; "Web-Based Automated Assessment for ABET Programs" the ASEE Gulf-Southwest Section 2002 Annual Conference, U of Louisiana at Lafayette, March 2002.

Gregory, James M. & Lloyd R. Heinze; "Helping Undecided Students Select a Major in Engineering," the ASEE Gulf-Southwest Section 2002 Annual Conference U of Louisiana at Lafayette, March 2002.

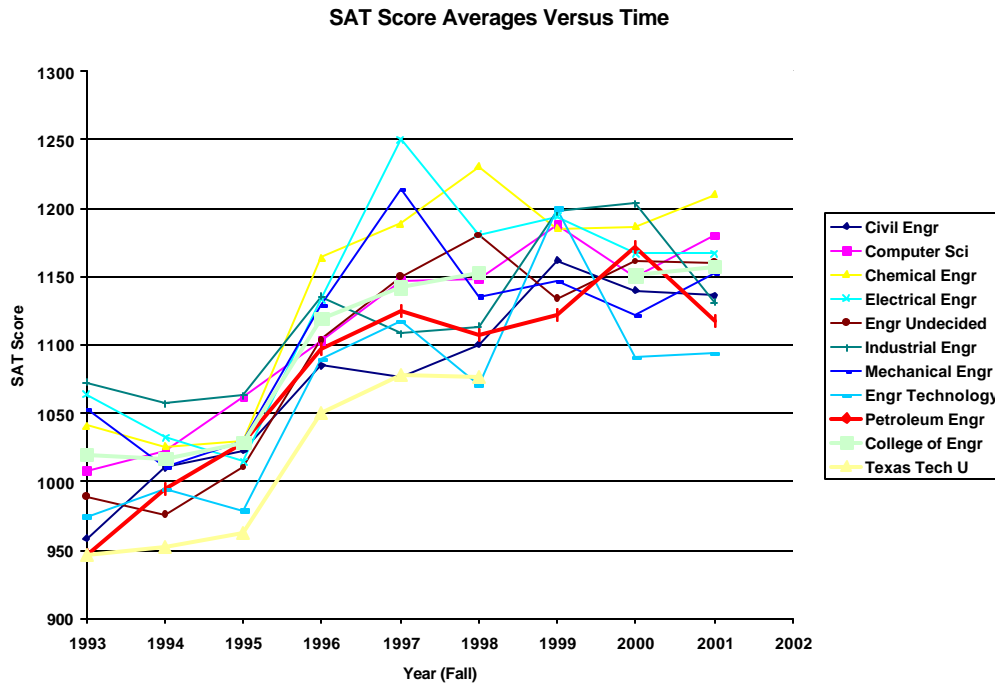


FIGURE 3
SAT SCORE AVERAGES VERSUS TIME

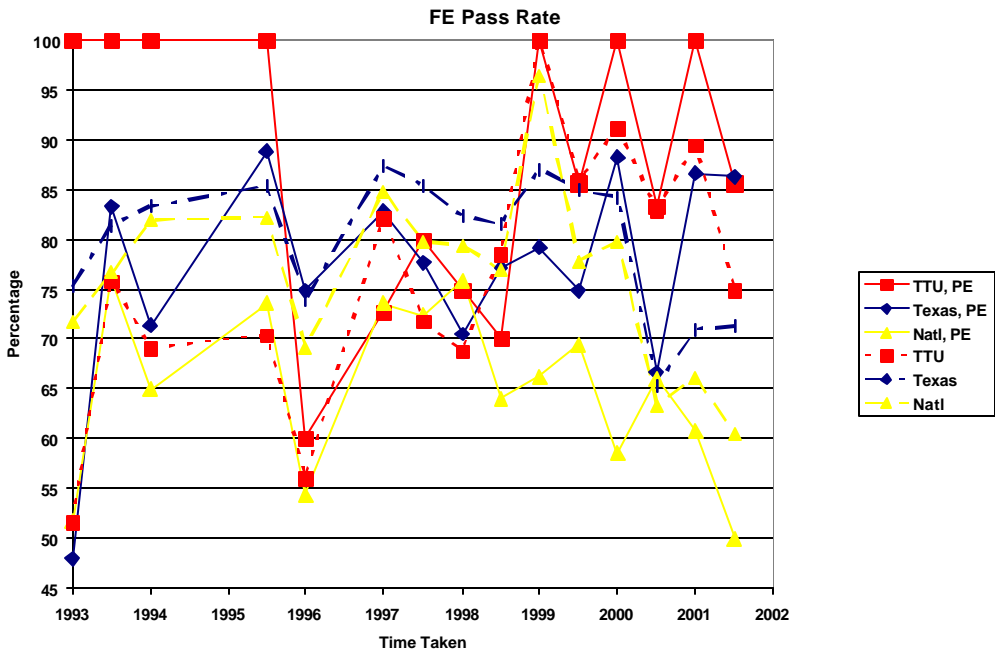


FIGURE 4
FE PASS RATE

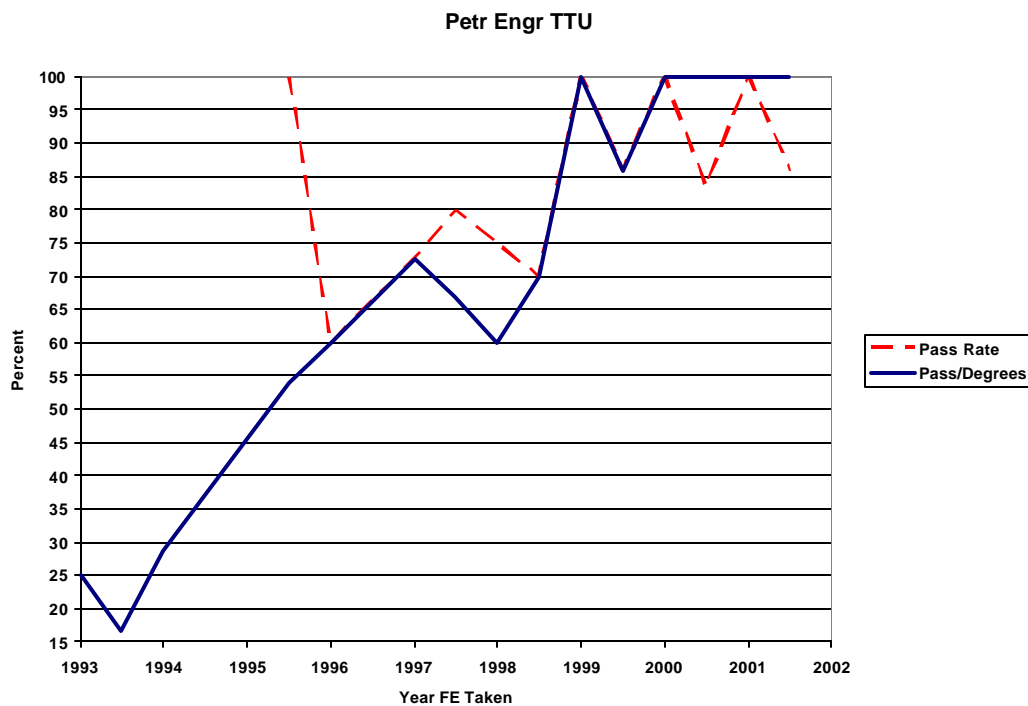


FIGURE 5
PETROLEUM ENGINEERING FE PASS RATE

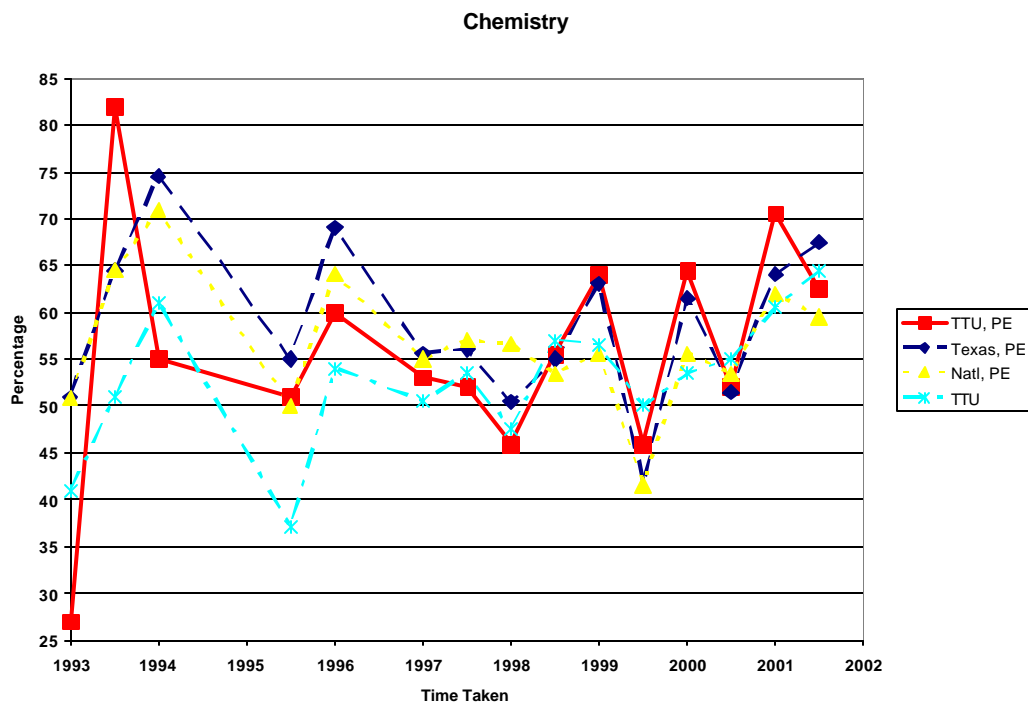


FIGURE 6
CHEMISTRY PETROLEUM ENGINEERING STUDENTS