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Engineering Boot Camp: An Intense, Transformative Program for Incoming Freshmen

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Abstract

This complete evidence-based practice describes a new summer boot camp program with objectives to prepare students for the rigors of university courses and increase student retention. This boot camp is a subset of a university wide program specifically for students entering the College of Engineering. It is not a remedial course and all incoming freshmen engineering students are encouraged to apply. This is an intense week-long course requiring students to attend lectures, complete homework assignments and projects, take exams, and partake in skills sessions meant to help students adjust to university life and increase their success in university level courses and thus retention in the college of engineering.

This program is assessed through evaluation of university retention data, student grade point averages, first semester math and engineering course grades, and surveys distributed at the end of the program. Preliminary data analysis confirms positive results for boot camp participants. In 2016, retention from first to second year of college was up by approximately 11%, and on a 4.0 grade scale, first semester math grades are about 0.5 points higher over non-participants. 2017 survey results show that after completing boot camp, 94% of participants felt prepared for their first semester classes, 97% felt confident about their freshmen year, and 96% are confident in their ability to do well in their major.

Introduction

This paper describes the Engineering Freshmen Intensive Transition (E-FIT) program, which is a week-long summer boot camp designed based on best practices for retaining students [1] and the Biology Intensive Orientation for Students (BIOS) program at Louisiana State University (LSU) [2]. Studies have shown that difficulty adjusting to college life for new students can lead to low grades and issues with persistence in completing a degree. [3], [4]. Stress can also negatively affect first-year students and in some cases lead to students dropping out of college [5], [6]. Furthermore, studies show that students who are academically unprepared for the rigors of university courses leave school without a degree [7]. This boot camp program is for incoming, first-year engineering students and aims to teach them effective study and time management skills in a forgiving environment prior to the start of classes, so that they have a greater chance of being successful in their first-year coursework. The boot camp also aims to help new students adjust to university life and feel a sense of belonging prior to the official start of the semester, since feeling settled in has been shown to be linked with persistence in completing a degree program [8], [9].

Many universities offer pre-college summer programs that offer students the opportunity to study on campus during the summer [10], [11], [12], [13], [14]. These programs vary in length and curriculum. Some offer students credit in their field or an opportunity to explore their academic options with non-credit courses. Many programs specifically target remedial students, in order to help them get college ready, or gifted students to offer them a challenge or opportunity to gain college credits before the official start of the semester. Other programs are only offered to low-

income, first generation college students [10], [11], [12], [13], [14]. This summer boot camp is unique is that it is for students from all backgrounds and skill levels, it aims to teach students how to be successful in college, and it does not necessarily focus on course content. Additionally, in order to help students feel a sense of belonging and start forming study groups, this program is engineering discipline specific, open only to incoming students enrolled in the fall semester, and it is closely tied to the first engineering course offered at the university. Boot camps at University of California, Santa Barbara (UCSB) and University of Washington (UW) are similar, but they focus on Math and Writing or Science and Math respectively [15], [16], which means that students will not necessarily meet others in their major.

All incoming freshmen engineering students are encouraged to apply to E-FIT, which is designed to suit students of all ability levels. Currently, there is space for 132 students (approximately 20% of incoming engineering students) to participate, but the program plans to be available to all incoming freshmen engineering students within two years.

Students selected for the program participate for one week in a course heavily linked to the Introduction to Engineering Design course (ENGR 100), which is required for all incoming freshmen engineering students. The course is offered the week before the start of the fall semester and students reside in their assigned dorm room for the upcoming semester. Students attend lectures by engineering and math faculty members, complete homework assignments and exams, as well as work on a team to complete a design challenge. Each day, students attend one engineering lecture and lab session as well as two math lectures and two math study sessions. In addition to course work, students attend skill sessions, which are designed to help prepare students for university life. In order to facilitate the program and help students get involved in the campus community, they are placed on a “pack” with five of their peers. Each pack is guided by a “pack leader” who is a successful engineering student that acts as a mentor to the new students throughout their freshmen year. Having a peer mentor can aid in new students adjusting to campus life [9], [17]. Additionally, studies have shown that positive role models and social support can impact the level of confidence and self-efficacy that students have in their ability to complete an engineering degree [18].

Methods

Participants

Boot camp participants were recruited through the Provost’s office and at various College of Engineering events. The Provost’s office created an informational website, called and emailed students accepted to the university, and sent post cards advertising the program to their homes. The College of Engineering Dean and the college recruitment coordinator included the program in their presentations to potential students during Nevada Bound and Best and Brightest events, university orientation, and Engineering Day. Students who want to participate complete an application online and are notified of acceptance in the spring prior to the start of their first semester. Students reported their motivation to participate in E-FIT for the following reasons: preparation for university and major specific coursework, learning more about their selected

major, moving to campus early, getting familiar with the campus, help with transitioning to higher education, and meeting people [19].

The participant selection process has been changing as the number of participants increases. In 2015 and 2016, an emphasis was placed on selecting cohorts who were diverse in race, gender, SAT/ACT scores, and selected major. Table 1 shows the gender and Pell eligibility for E-FIT participants and students enrolled in the College of Engineering. In 2015, the camp attendees were 20% female, and 19.5% Pell grant eligible (Table 1) and the majority identified as white or Hispanic (Figure 1), which was similar to the population of the College of Engineering that year (Figure 2), although the percentage of female participants in E-FIT was higher. A comparison of Figures 1 and 2 shows that the percent of Asian students enrolled in the College of Engineering was higher than the percent of Asian participants in E-FIT.

Table 1 shows gender and Pell eligibility data for E-FIT participants and students enrolled on the College of Engineering in 2015, 2016, and 2017.

	2015		2016		2017	
Demographics	**E-FIT**	**College**	**E-FIT**	**College**	**E-FIT**	**College**
Male	80.00%	84.00%	76.00%	83.00%	88.00%	82.00%
Female	20.00%	16.00%	24.00%	17.00%	12%	18%
Pell Eligible	19.5%	31%	23%	25%	23%	28%

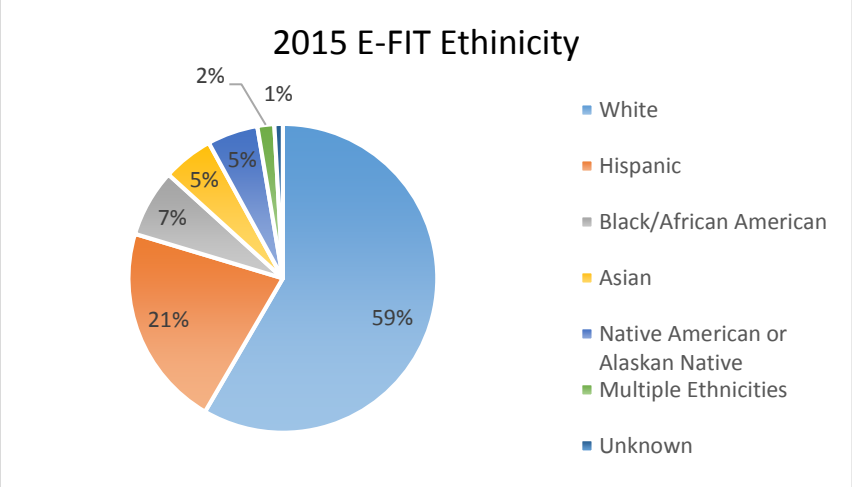

Figure 1 shows ethnicity data for E-FIT in 2015.

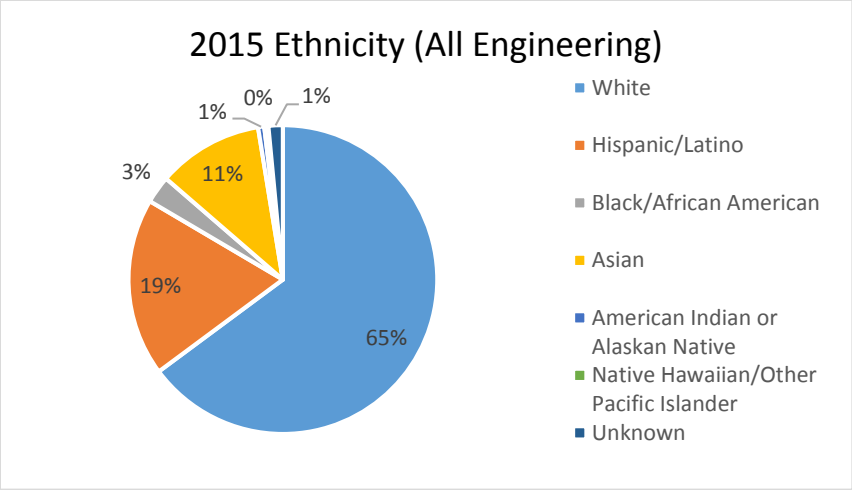

Figure 2 shows ethnicity data for the College of Engineering in 2015.

In 2016, the camp demographics were very similar to the previous year with most students identifying as white or Hispanic (Figure 3). Figure 4 shows the ethnicity data for the College of Engineering, which is similar to the 2015 data. Similar to 2015, there was a higher percentage of women participating in E-FIT (Table 1).

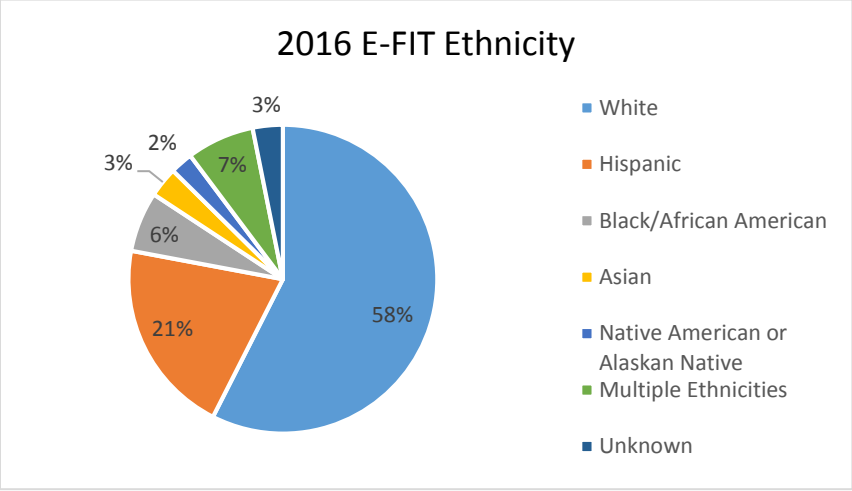

Figure 3 shows ethnicity data for E-FIT in 2016.

In 2017, the first 106 students were selected on a first come, first served basis and the remaining 21 students were randomly selected after applications were due. This new system was used in order to aid in the program planning in terms of housing, meal plans, and math placement. In 2017, the camp attendees were 12% female, and 23% Pell grant eligible (Table 1) with similar backgrounds in terms of ethnicity (Figure 5) when compared to previous years. College data is shown in Table 1 and Figure 6 for comparrison. In 2017, the percent of Asian students participating in E-FIT increased, while the percent of women participating decreased. The lower number of female students may be attributed to the selection process in 2017.

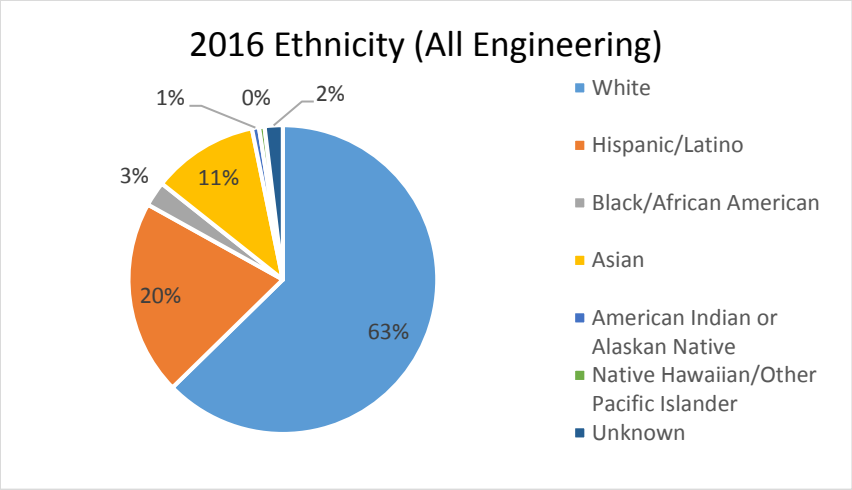

Figure 4 shows ethnicity data for the College of Engineering in 2016.

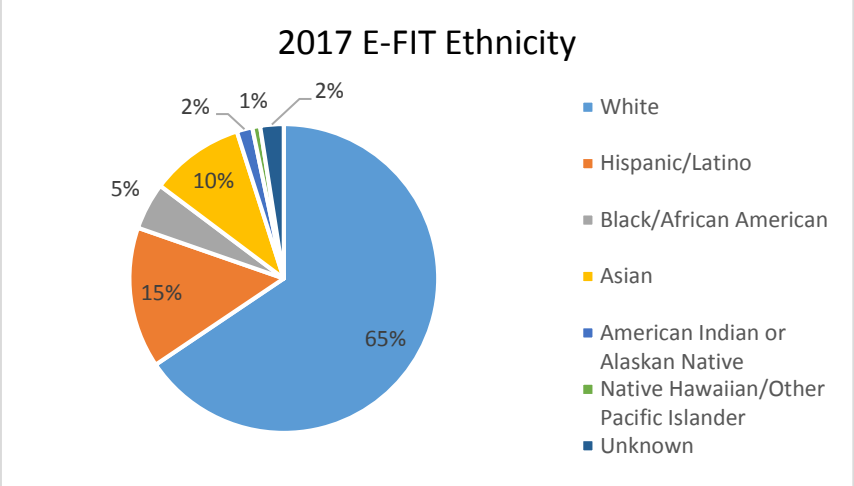

Figure 5 shows ethnicity data for E-FIT in 2017.

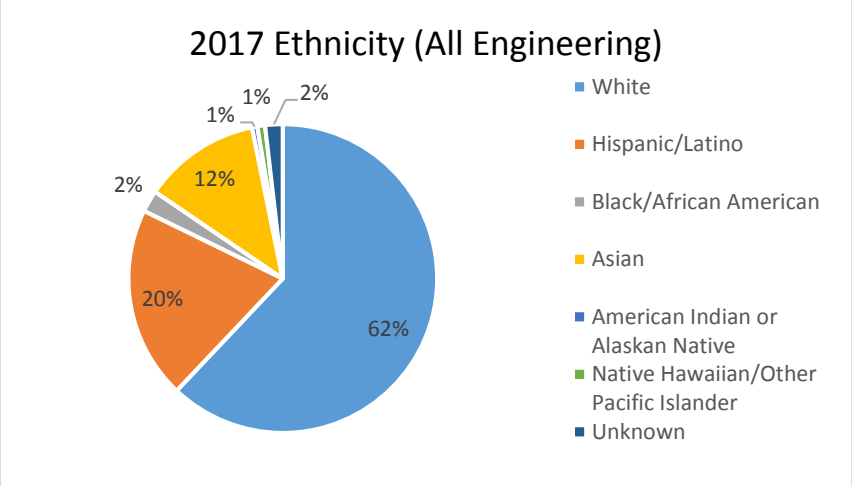

Figure 6 shows ethnicity data for the College of Engineering in 2017.

Procedure

Once students are notified of acceptance to the program, they are asked to pay the course fees and are automatically enrolled in the course. Students pay for housing, a special course fee, and one credit of tuition. Full scholarships for course fees and credits are provided for about 50% of students partaking in the program.

In order to facilitate the program and help students get involved in the campus community, students are placed on a "pack" with five of their peers. Each pack is guided by a "pack leader" who is a successful engineering student that acts as a mentor to the new students. Pack leaders introduce their packs to campus life, activities, and resources as well as hold daily debrief meetings. There are 2 pack leaders assigned to every 12 students to ensure that students can contact a leader at any time during the program. Packs are randomly assigned, but there is care to ensure that women and underrepresented minorities are not isolated when possible. Since we are teaching skills applicable to students in all majors within engineering, there choice of major is not accounted for when assigning packs.

Current engineering students apply to be a pack leader during the spring semester prior to boot camp. They are selected by a committee based on merit, written statements, references, and prior experience with the boot camp. The committee strives to hire a diverse group of pack leaders from all the different majors and levels within the College of Engineering, while giving priority to previous pack leaders who proved themselves to be reliable mentors. Approximately 75% of the Pack leaders apply to help multiple years in row. Between 2015 and 2017, the Pack Leaders were predominantly female (56% of Pack Leaders). The ethnic breakdown was as follows: 64% white, 19% Hispanic, 6% African American, 6% Asian, and 6% Pacific Islander over 3 years.

Pack leaders attend a four hour training session run by the Provost's office. The session includes FERPA certification, sexual harassment training, and a session held by counseling services on how to help distressed students. After the central training, the pack leaders attend a two hour engineering specific workshop where they are presented with complete job expectations and project safety guidelines.

In addition to pack leaders, two graduate teaching assistants are contracted to help. Teaching assistants lead some lecture sessions, manage the lab in the evenings, and help pack leaders as needed.

Intervention

The boot camp attempts to mimic an exam week during the semester. Participants are kept busy from 8 am to 9 pm most days attending engineering and math lectures, completing associated homework, taking exams, working in a lab to complete a design project, and attending skill building sessions. The engineering lectures are meant to build skills students will need in their ENGR 100 course as well as prepare them to complete the boot camp design challenge. Engineering lectures cover the design process, structured brainstorming, teamwork skills, projectile motion, aerodynamics, Microsoft Excel, problem solving, and cyber security. Throughout the week, students work in their packs to complete an engineering design project. In

2015 and 2016, students designed trebuchets and in 2017 they designed bottle rockets. A design competition is held on the final day with teams rewarded for getting closest to a target with their projectiles.

In addition to completing engineering activities, students attend math lectures twice a day. They attend the math class in which they are enrolled in the fall semester and complete daily homework assignments and two exams. This experience further introduces them to university level lectures and assignments as well as gives them practice taking exams in a low stakes environment.

In order to further prepare attendees for their first semester of college, students attend skill building sessions with the tutoring center, math center, student conduct office, and with the financial planning program office. Each sessions runs for an hour and is meant to provide students with information about resources available outside of the engineering department, which could help them be successful in their first semester of school and beyond. The university tutoring center presented an engineering specific session that focused on "tips and tricks" for successful note-taking, critical reading skills, listening skills, and time management. The tutoring center leveraged a homework assignment from one of the engineering lectures that students attended, in order to provide framework for teaching these skills. They also cover positive mindset, dealing with anxiety, and ways to use meditation in order to perform better on exams.

To further their knowledge of academic assistance available on campus, students attend help sessions with the Math Center. The Math Center offered help with written homework and use of a computer lab to complete online assignments. Tutors circulate the room to help students complete their assignments and review important concepts. Students must visit the Math Center five times throughout the boot camp week in order to get help with their daily math assignments. This is required so that students can experience the resources available to them during the semester.

Students are required to attend a skills session with the student conduct office in addition to learning skills directly pertaining to their course work from the tutoring and math centers. The office of student conduct focusses on maintaining a safe campus environment that is conducive to learning. The student conduct session discusses the rules in the student code of conduct and the potential consequences for violations of the code. This includes a discussion of campus trends, positive decision making around alcohol and drugs, Title IX, academic misconduct, and other issues that may bring a student to the conduct office.

The financial planning program office provides a session on financial literacy for students. Students are given money management tips, tools, and resources to set them up for financial success both in college and beyond. The office speaks with students about debt and mastering finances so students have the flexibility to invest in their education and contribute to their community's economic stability.

Program Evaluation

This program is assessed through evaluation of university demographics and retention data, student first-year grade point averages, first semester math course grades, ENGR 100 grades, and surveys distributed at the end of the program. In 2016 and 2017, surveys were distributed online by the Provost's office and the data was shared with the College of Engineering at the end of the fall semester. A survey was also distributed to all students enrolled in ENGR 100 at the conclusion of the Fall 2017 semester.

Results and Discussion

Data analysis confirms positive results for engineering boot camp participants in comparison to non -participants. Table 2 shows retention rates within the College of Engineering from first to second semester and from the first to second year of school. Retention rates of boot camp participants is higher in all cases. On average, retention after one semester are up by 6% and after one year retention rates are up by 8.7% for program participants compared to non-participants. An independent two-tailed t-test was run to compare the retention averages of the E-FIT participants and non-participants and the differences were found to be significant at $p<0.01$.

Table 2 shows retention rates for engineering students in 2015, 2016, and 2017.

	2015		2016		2017	
Retention	**E-FIT**	**No E-FIT**	**E-FIT**	**No E-FIT**	**E-FIT**	**No E-FIT**
Retention after one semester	95.58%	91.06%	97.66%	89.31%	98.50%	93.10%
Retention after one year	86.73%	80.07%	90.63%	79.87%	N/A*	N/A*

*Data not available as of publication date

Table 3 shows the overall grade point average (GPA) for engineering students after their first semester, as well as their first semester math and ENGR 100 course grades. Students who participated in E-FIT had higher GPAs in 2016 and 2017 than non-participants, but they were slightly lower for participants in 2015. An independent t-test showed that the differences in these averages were not statistically significant in 2015, 2016, or 2017. First semester math and ENGR 100 grades were higher for boot camp participants in 2015, 2016, and 2017. An independent t-test showed that the differences were only statistically significant in 2016 ($p<0.05$).

Since all participants received similar treatments, a statistically significant difference in grades after the first semester in only 2016 was unexpected. Independent sample t-tests were run to analyze the populations participating in the camp for differences in terms of high school cumulative GPA and scores from the SAT and ACT. In 2015, SAT scores were statistically significantly lower ($p<0.05$) for E-FIT participants than non-participants. There were no statistically significant differences between the participant and non-participant groups in 2016. Further evaluation of grades in future years may be necessary to explain the success of the 2016 cohort in terms of first semester grades when compared to the 2015 and 2017 cohort. In 2017, E-FIT participants had statistically significantly higher SAT ($p<0.01$) and ACT ($p<0.05$) scores than non-participants, but this did not translate to significantly higher grades in the first semester.

The higher test score for the 2017 cohort may be due to the selection process, since most of the students were admitted to the camp based on the order in which they applied.

Table 3 shows grade data for engineering students in 2015, 2016, and 2017.

	2015		2016		2017	
Grades	**E-FIT**	**No E-FIT**	**E-FIT**	**No E-FIT**	**E-FIT**	**No E-FIT**
Overall GPA	2.78	2.81	2.95	2.79	3.02	2.91
First semester math grade	3.00	2.93	3.08	2.76	2.74	2.52
ENGR 100 grade	2.95	2.88	3.16	2.88	3.02	2.75

In addition to assessing this program through evaluation of university demographics, retention data, and grades, surveys were distributed online by the Provost's office at the end of the program in 2016 and 2017. These surveys were completed anonymously and voluntarily and were not linked to previously collected demographics. The questions students were asked which pertained to this study included:

1. Why did you apply?
2. Would you recommend E-FIT?
3. Rate your confidence level towards your major, math courses, and freshmen year?

The most commonly cited reasons for applying to E-FIT were to prepare for university and major specific coursework, followed by learning more about their selected major. Other reasons cited included moving to campus early, getting familiar with the campus, and meeting people. Students were asked if they would recommend E-FIT to future students and 70% were likely or very likely, while 29% felt neutral toward a recommendation. Students were also asked to rate their confidence level toward their major, math courses, and freshmen year on a five point Likert scale ranging from not at all confident to very confident. Figures 7 and 8 show confidence levels for boot camp participants surveyed in 2016 and 2017 respectively. In both 2016 and 2017, the majority of students are somewhat to very confident in these three measures going into their first semester of college.

Figure 9 shows the results of a survey given at the conclusion of the Fall 2017 semester to ENGR 100 students via WebCampus. The survey asked two categorical questions:

1. Did you feel prepared for your classes at the start of the semester?
2. Do you plan to continue with their engineering degree?

Students who attended the boot camp (participant) were 13% more likely to say they felt prepared for their first semester classes and 4% more likely to be continuing with the engineering program than students who did not complete boot camp (non-participant). Independent t-tests were run on both data sets and the results for question 1 (feeling prepared) were statistically significant ($p<0.05$), while the results for question 2 (plans to stay in engineering) were insignificant.

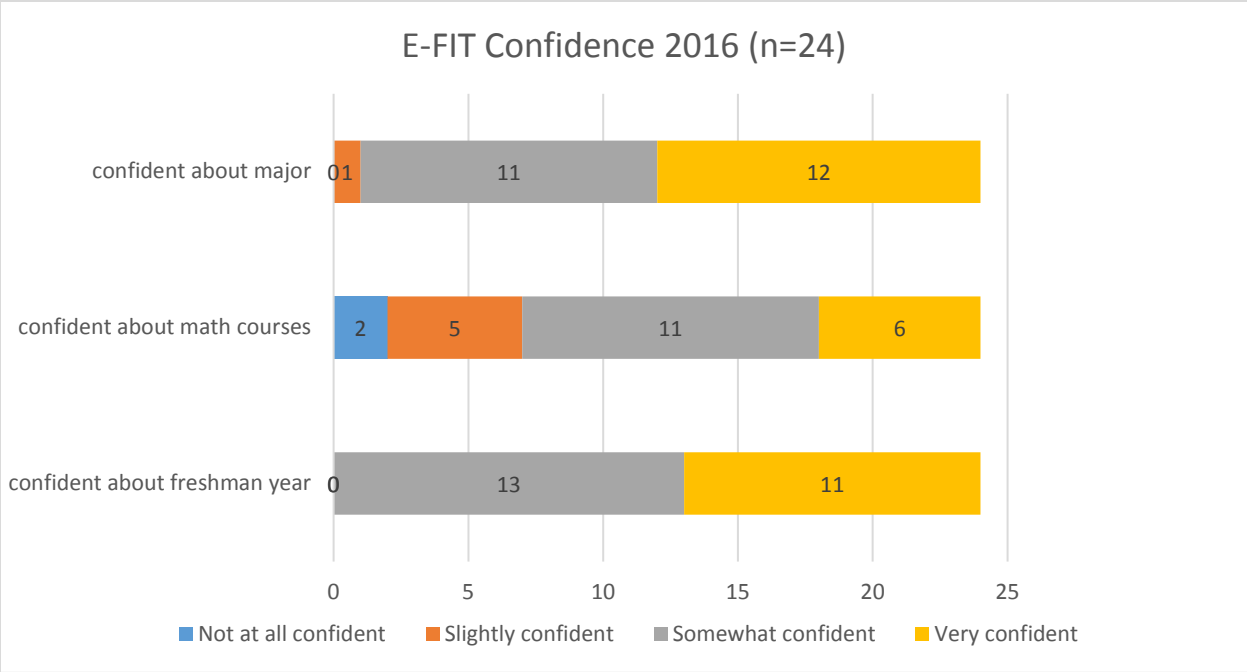

Figure 7 shows confidence levels for boot camp participants in 2016

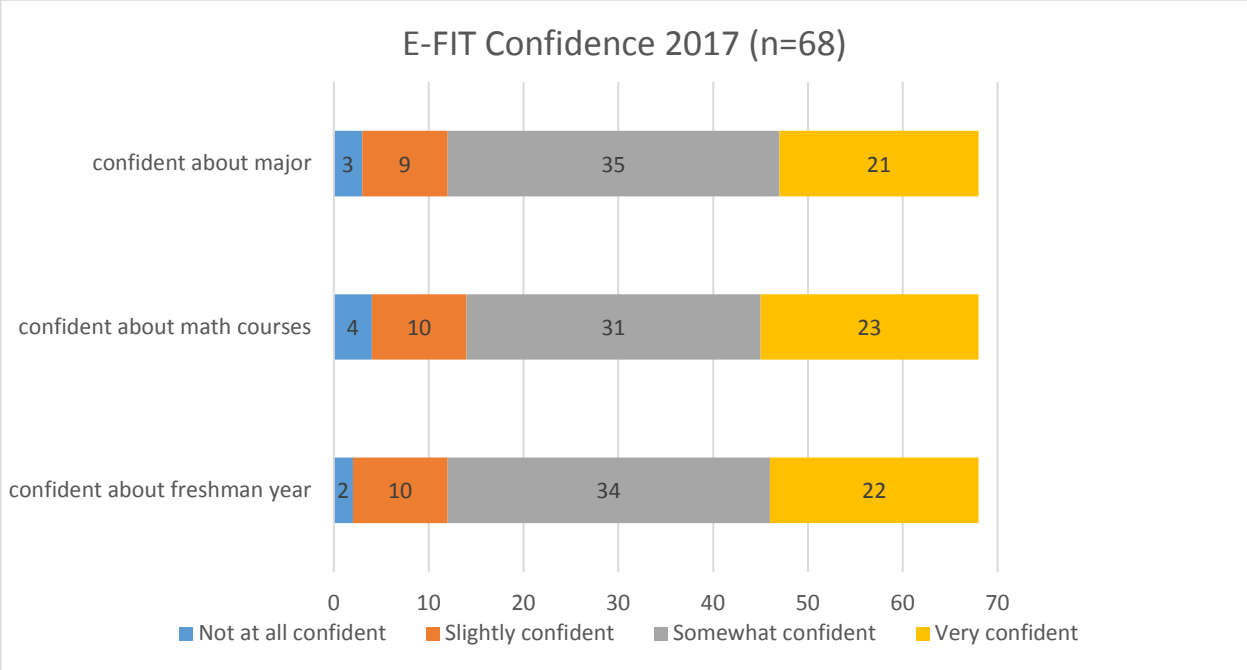

Figure 8 shows confidence levels for boot camp participants in 2017.

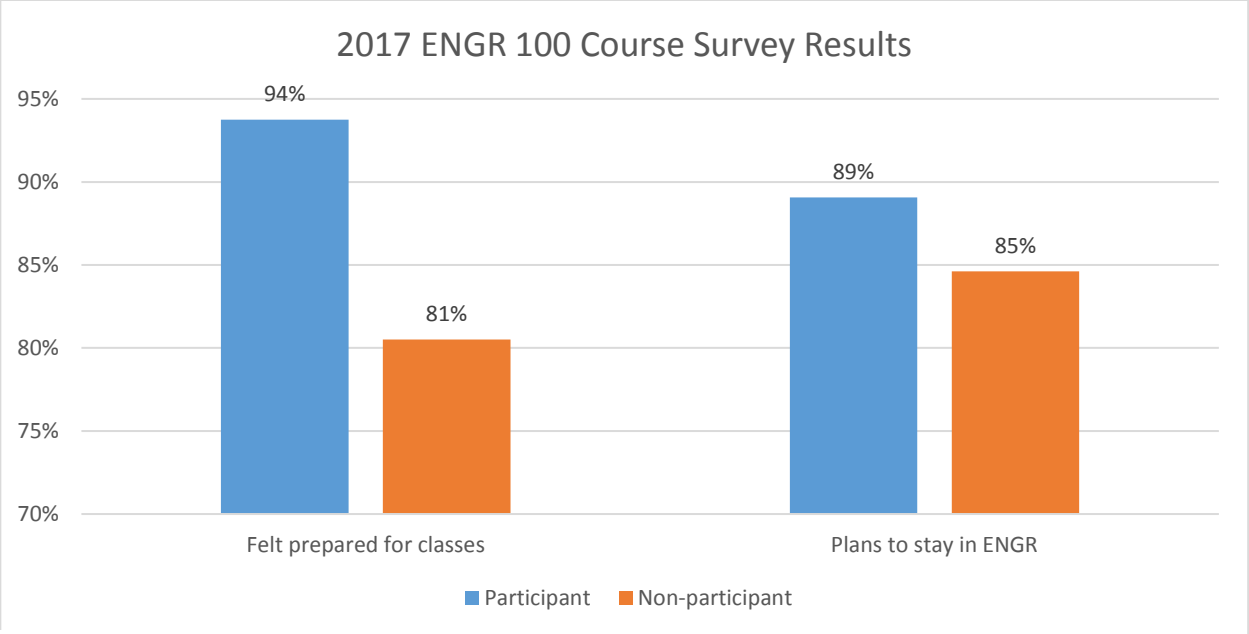

Figure 9 shows results from 2017 of the ENGR 100 class. Students partaking in boot camp felt more prepared for their first semester of college and were more likely to stay in engineering.

At the conclusion of the fall semester, E-FIT participants were randomly asked by the program director to comment on the program. One student highlighted the programs ability to help him academically and socially: “Boot camp set the tone for my freshman year and indeed, my college career as a whole. Because of boot camp, I was prepared to handle the challenging engineering curriculum. Most importantly, I gained lifelong friends that I can count on to be there for me both academically and socially.” Another student focused on how the boot camp experience helped her adjust to college life: “Moving away to college is a very challenging step in life, but the program helped me gain my footing before classes even started and got me acclimated to college life.” These comments align with the goals of the boot camp which were to help students adjust to college life, intill a sense of belonging, and teach academic skills that are essential to success in college.

Conclusion

In conclusion, the boot camp program was successful in increasing retention rates and the confidence levels of participating students. Retention rates were statistically significantly higher for first-year students all three years. 2016 and 2017 surveys showed that most program participants felt confident about their major, first math course, and freshmen year in general. A 2017 study showed statistically significant results that participants felt better prepared for their first-year classes.

An increase in retention rates is a positive outcome, but ideally the program will help students perform significantly better in their classes as well. The college will offer the boot camp program to a larger population in the future with changes made to support student success. In order to improve evaluation of the program, consideration will be given to new surveys instruments, which are linked to demographics and engineering identity.

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