Summer Immersion Program for First-Year Engineering Students as a Strategy to Increase Retention: First-Year Results

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Abstract

This work in progress describes the impact of a 10-day summer program in the retention rate of freshman engineering students during their first semester.
In the last three years, our School of Engineering has presented an increasingly high number of students leaving their majors leading to a low retention rate. Several reasons have been pointed out as possible causes for the high number of first year students leaving the engineering programs. In general, the transition from high school to college, as a difficult and new experience in the life of first-year students, has been suggested as one reason for the low retention rate (an average retention rate of 64% has been reported for our engineering school). To improve the retention rate, an intensive 10-day externally-funded summer immersion program for incoming first year engineering students from all majors (computer, electrical, industrial and mechanical engineering) was designed to provide an acclimation to college life, provide an introduction to engineering careers and promote self-confidence. Physics and Math topics were included in the theoretical part of the projects developed during the summer program to promote the student's interest in Physics and Mathematics courses.
The 2015 summer program impacted 67 students (34 mechanical, 18 computer, 8 industrial and 7 electrical) with a wide range of College Board scores, reflecting a variety of college preparedness levels. Students were divided in five groups. Each group was placed in a different classroom to work a hands-on project with an instructor and a student mentor. Groups were chosen to be multidisciplinary. To promote professional networking, there were at least three same-major students in the groups. Female students were placed such that, at least three women were in the group.
The 10-day summer program consisted on eight hands-on projects where students had the opportunity to relate practice to theory while working in an inviting environment. A tour to the campus facilities and a conference on good study habits complemented the 10-day summer program. The final day students had a "competition" using 3D printed cars they designed in one of the projects. All five groups were winners and prizes were scheduled to be picked up by October 2015 as a strategy to make personal contact with students, to have feedback of their university live experience, and provide them advice if necessary.
Data was collected to study the number of freshman students enrolled in the 2015 fall semester that returned in the 2016 spring semester. Retention for the total number of engineering students enrolled in fall 2015 was 87%. For the years 2012, 2013 and 2014 retention values were 80%, 78% and 73% respectively. Retention for students enrolled in fall 2015 that attended the summer program was 93%. For students who did not attend the summer program, retention was 71%. After revising the data and the outstanding reception from students, retention rates for future years seems very promising.

Introduction

During the last two decades, the world has become more global, competitive and particularly technological. The University of the Future needs to strength the areas of science, technology engineering and mathematics (STEM) in order to have well prepared and successful professionals[1,2]. Many students are not ready to face their new college life, it is necessary to provide them bridge programs to help them in this transition process. Since the 1990's, there

has been numerous efforts to improve the preparation of students for success in college. Summer immersion programs are one of the many strategies used to assist students to improve their academic development. By improving the student success, the retention and graduation rates accordingly will increase. These programs are designed to serve newly enrolled freshman in the fall semester in order to provide the tools necessary to begin their professional careers successfully.

The Engineering Summer Immersion Program (ESIP)

The Engineering Summer Immersion Program at our Institution is a three-year activity sponsored by the Department of Education (DE) grant (project number P120A140021), our program consisted of a 10-day workshop in the areas of computer, electric, industrial and mechanical engineering. Eight days were dedicated to hands-on workshops, one day was for general orientation and a tour through the campus labs and facilities, and the final day was for closing activities including 3D printed cars competition. The ESIP is programmed to annually serve 100 - 150 students.

The main objective of this program is to increase the retention rate of our freshman engineering students from all majors. To achieve this objective the projects were designed to attain two specific objectives: (a) expose the students to math and sciences while working on projects. We expected to spark students' interest in math, physics and chemistry (through the integration of real life applications to course content). (b) Improve the student self-confidence by providing them networking opportunities (to work the projects, groups were divided into teams of 3-4 students). In addition there were seven (three female and four male) mentor junior engineering students who provided extensive advising to their younger peers.

The key phases were:

Spring Outreach to Recruit Students

All newly enrolled engineering students were contacted during the spring-2015 semester by the PIs of the project. Students who completed the registration process were contacted by email or phone two weeks before the beginning of ESIP.

Projects

The ESIP consisted of ten days (5 hours each), from July 20 to 31, 2015, coming to a total of 50 contact hours. The curriculum was based on innovative activities designed to foster students' self-confidence and understanding on STEM subjects in order to prepare them for the first-year engineering courses. Table 1 presents a brief description of the ESIP curriculum.

Table 1. ESIP Curriculum and Contact Hours

Project title	STEM content and processes	Contact hours
General Program Orientation	-	5
Motivational conference/good study habits	-	4
Building rockets	Propulsion engine, height, thrust, impulse, drag, inertia, parabolic movement equations	5
Math in context: Cooking with the Sun	Parabola equation, forms of energy and energy transformations, types of convections, principles of heat transfer, graph and analysis of temperature vs. time	5
Renewable energy: Dye sensitize of the TiO2 Solar cells	Origin and classification of different sources of renewable energy, applied nanotechnology, energy transformations	5
Physics in context: Electricity	Electricity, atoms, electrons, chemical energy, principles of electric generators, electromagnetism, Faraday-Lenz Law	5
Fundamentals of mechatronics and robotics	Hardware and software aspects of mechatronics systems using Basic X microcontrollers, programming for led sequences and music production	5
CAD engineering drawing and 3D Printing	Use of SolidWorks Software to design, assemble and simulate models	3
Math in context: Rate of change	Dependent and independent variables, lineal function, equation of a straight line and its representation with graphs and tables	3
Physics of aerogenerators	Kinetic energy, electrical power, turbine	5
	Total	50

Group distribution

The 2015 ESIP impacted 67 students (34 mechanical, 18 computer, 8 industrial and 7 electrical) with a wide range of College Board Scores, reflecting a variety of college preparedness levels. Students were divided in five groups. Each group was placed in a different classroom to work a hands-on project with an instructor and a student mentor. Groups were chosen to be multidisciplinary. To promote professional networking, there were at least three same-major students in the groups. Female students were placed such that, at least three women were in the group.

Data analysis and discussion of results

The institution collects extensive students' retention data every semester. However, retention data is reported on a yearly basis and no data is analyzed on a semester basis. Important conclusions may have been overlooked with this practice especially for freshman students

returning to the engineering school after the first semester. In this work, we reported retention data for freshman students after their first semester. Figure 1 shows the number of freshman students enrolled in fall semester compared to the number of students returning to the program the next spring semester. Data is presented for the last four years.

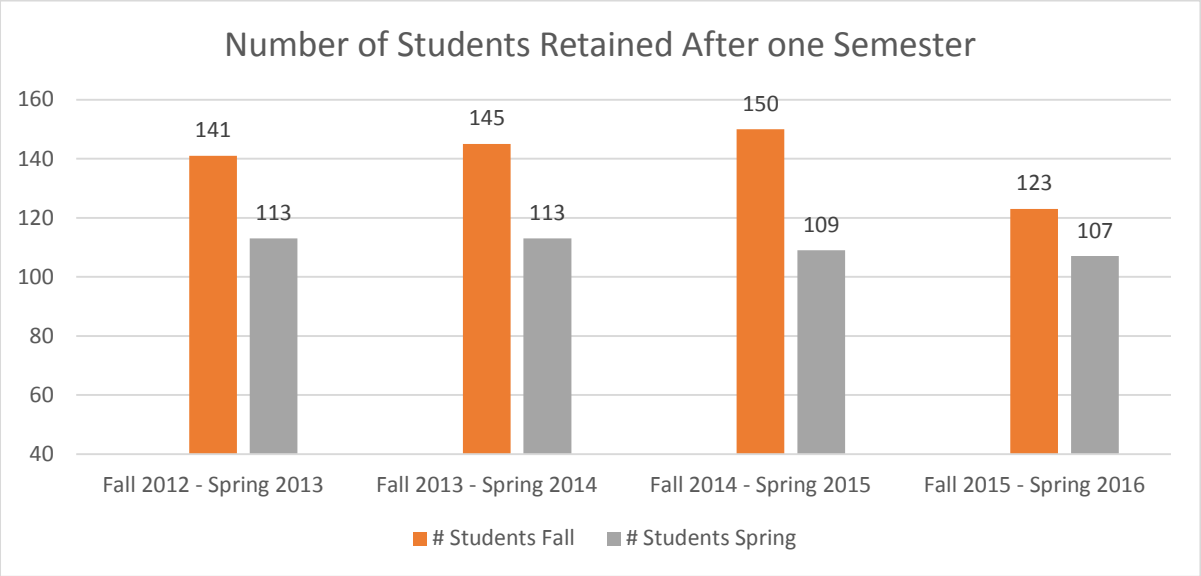

Figure 1. Number of freshman students enrolled in fall semester versus number of students returning to the program the next spring semester.

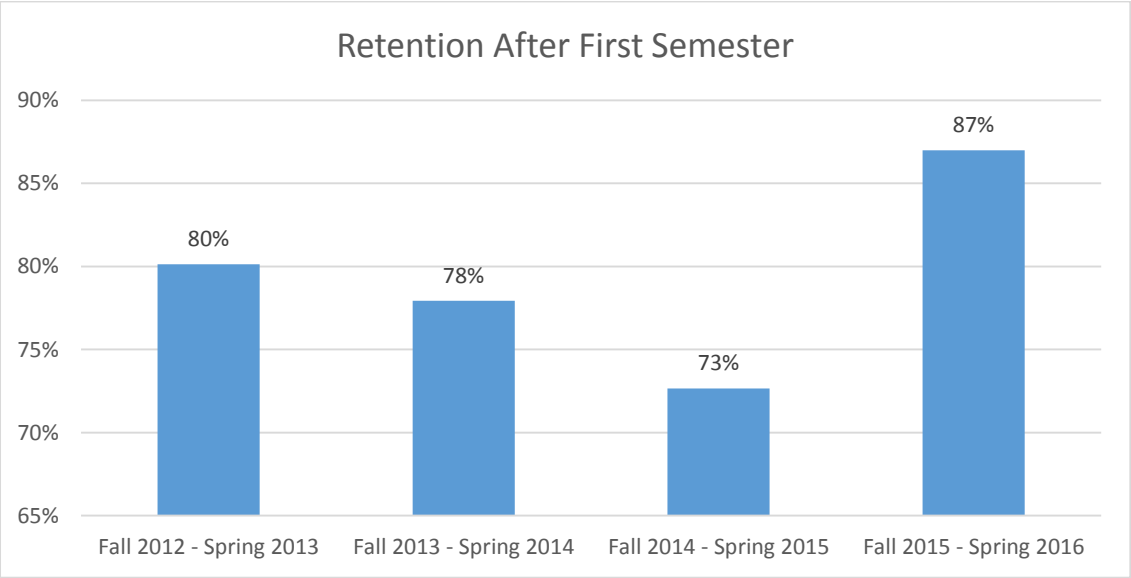

Figure 2. Retention of freshman students after their first semester in the engineering program.

In figure 1, we can see that the enrollment in fall 2012-2014 is very stable around 145 students, however in fall 2015 the number of enrolled students is noticeable lower (123). Despite this enrollment difference, it is also noticeable that the number of students returning in spring 2016 semester is comparable to the previous years where enrollment was higher (113 retained students in 2012 and 2013, 109 retained students in 2014 vs 107 in 2015).

The retention rate increased for 2015 after summer program was implemented (figure 2). Retention rate was continuously decreasing from 80% in 2012 to 73% in 2014 but in 2015, after our summer program, there was an important jump to 87% which is a very encouraging result.

As mentioned previously, the number of students impacted by the program was 67, however the total number of freshman students enrolled for fall semester was 123. This means that 56 students did not participate of the ESIP. We compared the results of retention in both participants versus non-participants of the ESIP groups. Results are shown in figures 3 and 4.

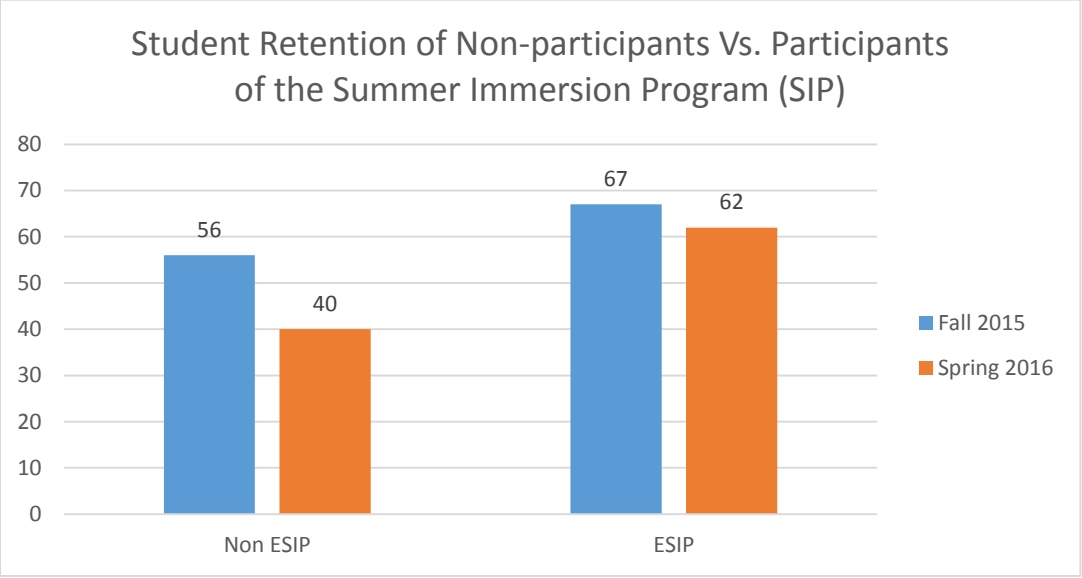

Figure 3. Comparison of Student retention on students who did not participate of the Summer Immersion Program vs students who did participate of the Summer Immersion Program.

Figure 3 shows that of 56 freshman students who did not participate in the ESIP, 16 students dropped from the engineering program. However, of 67 freshman students that did participate in the ESIP, only five (5) students dropped from the engineering program. Percentage values of this data are showed in figure 4.

Figure 4 shows the important impact of the summer immersion program in the retention of students that participated in the ESIP (93%). Notice that the retention of non-participants of the summer program is 71% which is even lower than the retention of previous years.

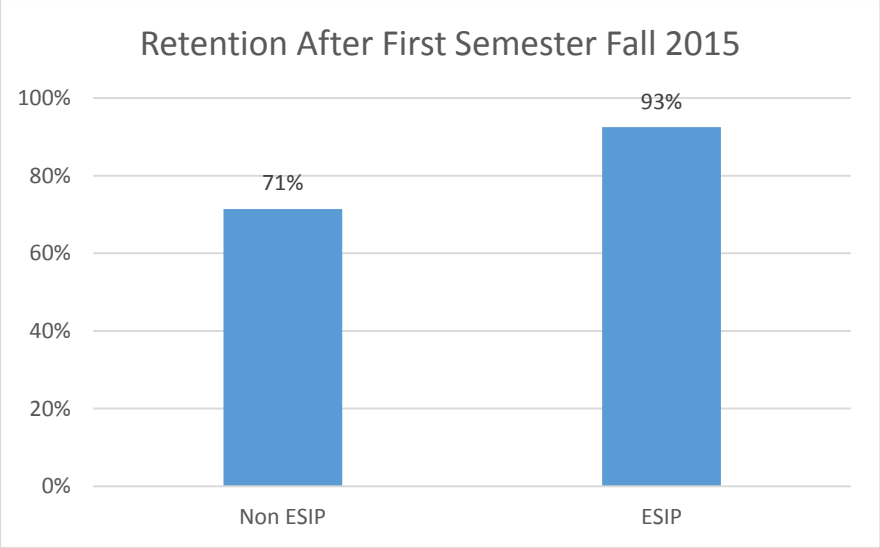

Figure 4. Retention of freshman students after fall semester 2015. Non participants of the ESIP versus participants of the ESIP.

According to the results shown in figures 3 and 4, the increase in the retention rate can be attributed to the 2015-ESIP.

Unexpected outcomes

It is worthy to mention that after the summer program, we gladly noticed a highly unusual number of freshman students involved in extra-curricular activities such as student associations, special projects and undergraduate research. All of them were participants of the ESIP. The exact number of students involved in these activities however needs to be documented. To the best knowledge of the authors this never happen before in this institution. Another unexpected outcome was that most of the student mentors (7 students) mentioned their interest to continue academic careers.

Conclusions

Objective of the summer program was successfully attained. Collected data shows promising results of the ESIP in terms of impacting the retention of newly enrolled freshmen students. Comparing first semester retention from years 2012 through 2015 an important increased is observed jumping from 73% in 2014 to 87% in 2015.

These results confirm that taking care of the newly enrolled freshmen students has big impact in their retention rate. More results, however, are needed to validate this affirmation.

Focus groups are being considered for future years.

Acknowledgement

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