

Making a Connection with First-Year Engineering Students

Eric W. Johnson

Valparaiso University. Valparaiso, Indiana

Laura Sanders

Valparaiso University. Valparaiso, Indiana

Abstract

Retaining first-year engineering students is an area of concern for many colleges and universities and has recently received even more attention. While time can be invested in implementing strong first-year courses and general support programs, the fact still remains that some students will leave engineering during the first year without truly experiencing the possibilities that engineering has to offer them.

Increasing student persistence in the field of engineering for all students is a complex task that has no obvious solution. One approach is to find the factors that have the greatest impact on student success and to support all students in these areas. Some factors can include academic preparation, interest in engineering topics, additional activities, study habits, and sense of community.

The purpose of this study was to determine how these primary factors affect first-year student performance and retention. A student survey of first-year students at midterm of the first semester was implemented to collect information on the 2008 cohort. The survey concentrated on student confidence in various areas, study habits, campus activities, and sense of community. The results from this survey uncovered several potential factors such as participation in study groups and student organizations as well as a sense of belonging that are impacting the success of the engineering students at our university.

Introduction

Engineering student retention is a high priority for many institutions. The main reason is that there continues to be a strong need for engineering graduates in the workplace, not only to meet the requirements of today's industries but also to keep the U.S. at the forefront of technological advancement. Statistics show that from 2006-2016 the number of employed engineers is projected to increase 11%.¹ At the same time, since the year 2000, bachelor degrees in engineering have increased only 5% or less each year.² Recruiting and retaining engineering students will help ensure that there will be enough engineering graduates. While we believe meeting industry demand is an important reason for improving retention, we also feel that we have a moral obligation to ensure our students, who are motivated to study engineering, graduate in a timely manner. To that end, we continue to investigate how we can retain as many of our students as possible while still maintaining a high academic standard.

There are a number of factors that influence engineering student persistence. These include those related specifically to academics such as the students' academic foundation from high school along with their motivation and determination in tackling the rigorous first-year engineering coursework. There are also a number of other factors, however, that also contribute to their persistence to stay an engineering student such as the academic support they have available and the opportunities for engagement in the college and university community. The purpose of our study was to determine how some of these other factors affect the performance and retention of our engineering students. While this study is focused on our first-year students, the goal is to follow this cohort throughout their four-year program and continue to investigate why students leave the college.

This paper outlines our research to date and is organized in the following manner. In the next section, a summary of previous work is given. Then our survey tool is outlined and the results from this year's cohort are presented. This is followed by a projection of our future studies and the plan for using the data to improve our retention numbers. Finally, we finish with our conclusions about the study to date.

Related Work

Over the past two decades numerous articles have been written concerning the retention of engineering students. Many review the effectiveness of first-year engineering programs or specific introductory courses. Other articles investigate retention of underrepresented populations. For this paper, we will focus on the work of surveys in helping determine retention and performance factors and also summarize some of the recent research done to investigate the impact of social capital on retention.

One of the early institutions that used surveys to try and understand first-year retention was the University of Pittsburgh. They developed a survey that measured students' attitudes about engineering and their academic abilities in specific areas (Physics, Calculus, etc.).³ The study at Pittsburgh found that the primary reasons that students stayed in engineering was that they had a good overall view of engineering, they enjoyed their math and science courses, and they had confidence in their academic abilities in their Physics and Calculus courses.⁴ Another public institution that utilized student surveys for investigating retention was Arizona State.⁵ They used the results from a previous study of retention by the National Action Council from Minorities in Engineering⁶ to design a survey that would give them a better understanding of why their students studied engineering. They found that the main factors were interesting work, chance for a good salary and numerous job opportunities. In contrast, students switched out of engineering due to the fact they did not like engineering. In both cases, the authors state that attitudes of students can vary from university to university depending on the students learning environment including the courses taken and academic support for first-year students. For our study, we integrated some of the components of the University of Pittsburgh Freshman Attitude Survey when we developed our survey but most of the questions were specific to the engineering environment at Valparaiso University. Our survey instrument will be discussed in the next section.

Social capital is an idea that has been highlighted in a number of areas including sociology, political science and economics. It involves social networks along with their social norms and the value of these in working toward a mutual goal.⁷ Social Capital was linked to engineering education by Brown, Flick and Williamson.⁸ In their paper, the authors argue that universities need to develop student social capital so that upon graduation, students will be ready for the workforce, have higher civic engagement, and be more innovative and productive in their work. They also begin to explore the link between retention and social capital by providing examples of the students' sense of community and its influence on students leaving engineering.

Many universities are striving to build this community with engineering students in various ways in the hope that it will increase student persistence. For example, there have been numerous papers summarizing the positive impact of learning communities on engineering retention.^{9,10} Learning communities are primarily found at large universities and try to combine a smaller group of students, faculty and perhaps industry partners to create a more effective environment for learning. A similar idea is the use of First-Year Interest Groups (FIGS). These also help students' transition from high school to college by placing small cohort groups in the same classes and residence halls. The University of Wisconsin has extended this idea to engineering and created engineering-specific first-year interest groups (eFIGS).¹¹ Results from these studies show that learning communities and first-year interest groups increase social capital and therefore can help retain engineering students. Along the same lines,¹² studied the correlation between social integration and retention. They found that a sense of community among first-year students was a positive predictor of student persistence. While what constitutes a sense of community may vary from student to student, participation in student organizations, membership in fraternities or sororities, support for residence or ethnicity, and campus employment were shown to have a significant positive influence. One engineering example that validates this point for minority engineering students can be found in work done by Prewitt, Eugene and Daily.¹³ The authors of this study found that membership in the National Society of Black Engineers provided first-year African American engineering students with a mentor relationship that increased their social capital and influenced their decision to stay in engineering.

For our study, we wanted to not only investigate how students assessed their abilities in their first-year math, science and engineering courses, but we also wanted to gain a better understanding of their life outside of class; what activities they were involved in, how they studied, if they solicit academic help when needed and their connection with the college. These results helped determine if each student had developed a connection with engineering, the college or the university.

Survey Tool and Results

To better understand first-year students in the College of Engineering and their social capital, a survey was developed and administered to all the students enrolled in the *Fundamentals of Engineering* course during the fall semester of the first year. This class is an introductory course, which offers students the opportunity to explore the basics in different areas of engineering. The data studied from this survey represents results from all the engineering and pre-engineering students enrolled in this course. The results of this survey will be used to compare their

responses with their performance in the College of Engineering to study potential factors that can increase or decrease academic performance and retention.

Of the 108 students that completed the survey in the Fundamentals of Engineering course, there were 80 students enrolled in the engineering program, 23 in the pre-engineering program, and 5 with majors other than engineering. Since the objective of this study was to determine the sense of community among those students pursuing an engineering degree, the survey results from those students with other majors were not included, leaving 103 student results to be used in the study. The students included 87 male students and 16 female students. The purpose of the survey was to compare the attitudes and actions of successful first-year engineering students with those first-year engineering students either on probation or that left the college. After the first semester, a group of 21 students leaving the college or on academic probation were identified as the underperforming group to compare to the group of 82 students progressing toward an engineering degree in good standing as the successful group. The comparison of survey responses from these two groups will be presented in this section.

The survey included four basic sections that will be described to better understand the direction of this research into the students' sense of community or social capital. These sections investigated the confidence level of the student in certain areas, study habits and their willingness to ask for help, involvement in campus activities, and engagement in the College of Engineering (CoE) community. While we believed that engagement in the CoE community was the key indicator, the other categories were included to get a sense of the overall confidence and engagement of the student.

The first section provided a list of 11 subjects or skills in which the student was asked to check the response that best described how confident they were in their abilities given the subject or skill. This was done using a Likert scale with 5 being "very confident" and 1 being "not very confident". The list consisted of academic subjects (Math, Physics), communication skills (Writing, Class Discussion, Speaking), study skills (Test Taking, Time Management), teamwork, and getting involved. These results did not show significant differences between groups except for the student confidence level in the area of Physics. Both groups rated their Physics confidence level lower than all other categories. The results showed average confidence level of 3.30 for the successful group and 2.19 for the underperforming group of students.

The second section included a series of yes/no questions to determine the student's study habits and willingness to ask for help from peer tutors or the instructor. The questions were:

- I prefer to study by myself.
- I have already formed a study group.
- I feel comfortable working in a team.
- I participate in the Hesse Center for GE100 help.
- I participate in the Hesse Center for Physics group study sessions.
- I go to the Hesse Center for tutoring when I have a question.
- I go see my professor when I have a question.

While the responses to these questions showed a slightly lower percentage of underperforming students seeking help from peer tutors than the others, approximately 50% of each group reported seeking help from the instructor when needed. The most informative results from this section focused on whether the student had already joined a study group. 48% of the students in good standing had joined a study group while only 29% of the underperforming students had. This result shows a statistically significant difference between the two populations at a confidence level of $p=0.059$. The benefits of study groups were supported by this result, but it does seem to contradict some of the responses in the first section of the survey. While there was no significant difference indicated in the confidence level of the students when working in teams, there was a significant difference in the action the students took when deciding whether to join a study group. This difference in results of confidence levels and actions was noted and will be considered for future study.

The third section of the survey targeted involvement in campus-wide activities. These activities included athletics, engineering student organizations, faith activities, tutoring programs (Hesse Center), the honors program (Christ College), and campus student organizations. The questions were:

Are you participating in:
Christ College?
Engineering Student Organizations?
Chapel Activities?
Bible Studies?
The Hesse Scholar Program?
The IT Fellow Program?
Athletics?
Intramural Sports?
Additional Campus Activities?

No significant differences were revealed through student participation in campus-wide events outside the College of Engineering, but a significant difference was seen in the responses regarding participation in engineering student organizations. Only 10% of the underperforming students had started participating in an engineering student organization while 46% percent of the students in good standing had already started participating. This result shows a statistically significant difference between the two populations at a confidence level of $p=0.0013$.

The last section of this survey targeted the student's engagement in the College of Engineering community. These questions included student's participation in events, their interaction with Engineering faculty, staff, and other students, and their sense of belonging in the College of Engineering. The questions were:

Did you attend the fall picnic?
Did you feel like you belong in the College of Engineering?
Are you comfortable going to CoE faculty and staff with questions or concerns?
Do you have close friends at Valpo that are also engineering majors?
Are there other students on your floor that are also engineering majors?

Both groups of students reported a high comfort level with COE faculty and staff and exposure to other engineering majors in their residence hall and other activities. The sense of belonging in each group however was very different. While only 1% of the students in good standing felt like they did not belong in the College of Engineering, 29% of the underperforming students felt they did not belong. This result shows a statistically significant difference between the two populations at a confidence level of $p < 0.0001$.

Future Study and Plan

Based on the results of this pilot research, it is clear that further study and additional programs in this area are needed to impact the retention and success of engineering students at Valparaiso University. While this initial survey showed that a student's social capital is a significant factor in a student's success in the College of Engineering, further study should be done to confirm this finding and to reveal other factors to predict retention. The first step in this study is to continue to track and survey this initial cohort group during their second and third years. This will allow the opportunity to study whether responses to the same questions bring the same results in later years and if any other factors emerge in later years that affect retention. The academic history of this group will also be reviewed to determine if any significant indicators success are revealed. The second step in further study is to refine the survey tool to begin tracking the next incoming cohort group. Revisions to the assessment tool will include clarifications between the student's confidence level and the actions they take as well as an additional section on the individual student's learning style. Both of these actions will allow us to better understand confidence levels and the social capital of the engineering students.

In addition to further study, actions will be taken to address the areas of concern that have already been identified. These areas are student confidence in physics, participation in study groups, engagement in engineering student organizations, and the sense of belonging in the College of Engineering. Since a physics help session supported by the engineering tutoring center already exists, more extensive promotion of this opportunity will be added in addition to closer collaboration with the physics faculty.

Programs will also be planned to increase the social capital of the students. Actions will be taken to further promote engagement in the engineering student organizations by offering an engineering society fair or joint social activity for first-year students during the first couple weeks of the fall semester. This will not only allow the students to learn more about the engineering societies, but also time to socialize with each other during the event. The engineering societies will also be encouraged to organize additional social events during the fall semester to enhance these relationships and sense of community. These events should be promoted through the introductory engineering class that all first year students participate in. Further study will also be done into social groups, first-year interest groups, mentor programs, and learning communities to select programs that will help all students have a better sense of belonging.

Conclusions

The results of the survey in this pilot study showed that successful first-year engineering students at Valparaiso University have a stronger sense of community and are more engaged in engineering activities than underperforming students. Some areas that showed significant differences between these two groups of students were participation in study groups, engagement in engineering student organizations, and the student's sense of belonging. This initial study will be followed by additional research on this group of students as well as incoming students and programs to target the areas of concern identified in the study.

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Biographical and Contact Information

Eric W. Johnson is the Brandt Professor of Engineering and an Associate Professor in the Electrical and Computer Engineering Department. His interests include engineering education research and international engineering. Eric can be contacted at Eric.Johnson@valpo.edu.

Laura Sanders is the Director of the Hesse Learning Resource and Assessment Center at Valparaiso University. Her responsibilities include recruiting, retention, and assessment in the College of Engineering. Laura can be contacted at Laura.Sanders@valpo.edu.