

Students Evaluating Significant Factors on Retention: A Statistical Analysis

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Abstract - One of the most important measures of performance in education is retention, especially during the first two years in engineering majors. Several retention programs among higher education institutions have been implemented to increase retention rate. However, how successful have been these programs? How serious do these institutions have taken student retention? And most important, have these programs taken into consideration the students' opinion about retention? The School of Engineering and Textiles at Philadelphia University have implemented a student-oriented research study to evaluate the significant factors that affect retention from the students' point of view. Freshman and sophomore engineering students guided by this author, designed and administered a survey on campus among freshman and sophomore students. Then, a statistical analysis is conducted to determine the significant factors that affect retention from the students' point of view, and to identify correlations that can be used to predict and prevent attrition.

Key words – retention and attrition, statistical analysis, student-oriented survey.

INTRODUCTION

Recruiting and retention have become a critical issue in engineering education, and subsequently have become subject to several research studies. Over the last three decades the attrition rate in the US have increased considerable, in 1975 attrition among freshman engineers was 12%, by 1990 it was over 24% [1]. A more recent longitudinal study conducted from 1992 – 1998 surveyed 119 colleges and university across the US, and report that about 25% of entering first-year freshman declared intention to study science and engineering degrees, and that by the

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second year 25% of these students have dropped out or change their major [2].

Faculty members, school administration, parents and students are concerned about these facts, and consequently looking for means of increasing retention. Several retention programs among higher education institutions have been implemented to increase retention rate, such as first year-experience, freshman seminars, summer bridge programs, mentoring programs, and many more. However, how successful have been these programs? How serious do these institutions have taken student retention? And most important, have these programs taken into consideration the students' opinion about retention?

In recognition of the need to revert this trend, the School of Engineering and Textiles at Philadelphia University have implemented a student-oriented research study to evaluate the significant factors that affect retention from the students' point of view. Freshman and sophomore engineering students enrolled in the courses Introduction to Engineering, and Engineering Statistics respectively, guided by this author conducted a research study to evaluate retention across campus. The students; grouped into six teams with members of both classes, designed a survey with questions that according to them affect retention. The questionnaires of all teams were compiled and returned to the students, whom rated the importance of each question. Finally a condensed survey with the top 35 rated questions was compiled.

Each team was assigned to analyze one of the five schools that grant an undergraduate degree at Philadelphia University. Then, each group administered a random survey among freshman and sophomore students at each school (total sample size $n = 474$), and based on the data collected, a statistical analysis is performed to determine which factors by school are significant in retention. The analysis compares the significant factors about retention among schools, gender, and each school versus the overall university. The analysis includes linear regression models that associate student's performance with behavior, lifestyle and study habits.

LITERATURE REVIEW

Over the last few decades, attracting and retaining the engineering students is becoming more challenging. In 2006, the retention rate of national first to second year college students was only about 70% [3]. Results indicated that students with better academic skills and mathematically reasoning ability are more likely to persist [4], and students who persist in engineering study had significantly higher level of emotional intelligence and social competencies than those who withdrew [5]. The most reported factors influencing student retention include gender, attitude, academic environment, and instructional methods. Within genders, GPA (grade point average) and SAT-math are primary factors associated with persistence, and between

genders, size and direction of gender difference in persistence varied across institutions [6]. Clearly, the freshmen year is very critical for the retention of engineering students. Such persistence depends not only on the knowledge and skills they learned, but also on the attitudes they bring into the college [4]. To increase the retention of engineering students, several methods have been tried, such as implementing active and cooperative learning, targeted advising and mentoring, engineering entrepreneurship program among students. It was found that active learning enhanced long-term memory, facilitated interpersonal skills and provoked student resistance [5-7]. Entrepreneurship program, as another effective way to build up confidence in study as well as accumulated teamwork and leadership skills, not only improved the retention, but also increased the GPA and academic performance of engineering students [8].

Tough it is apparent for every body the importance of implementing retention programs; it is surprising how little attention give to the most elementary forms of assessment [10]. Tinto [11] reports that students are more likely to graduate if they are more involved in student's related activities, and are considered as valued members of the institutions. Thus, addressing these two critical aspects about retention, we have implemented in the School of Engineering at Philadelphia University a retention research project that involves the active participation of freshman and sophomore engineering students.

SURVEY DESIGN AND DATA COLLECTION

Students enrolled in the Introduction to Engineering (freshman) and Engineering Statistics (sophomore) courses were grouped into six teams including members of both classes. Each team designed a questionnaire with 35 to 50 questions that they felt were determining causes that affected student retention. Then, all the questions were compiled and distributed back to them; such that each team could rate the relevance (1-10, 10 the highest) of each question with respect to retention. Finally, the questions were tabulated and sorted in descending order based on the total relevance score. The final version of the survey is presented in Table II and includes the top 35 rated questions. It is important to mention that the 95% confidence interval of the average relevance of the top 35 questions is (6.5, 7.4), which indicates the uniformity of the criteria among the students in identifying the factors that affects retention, and consequently make us confident that the designed survey accomplishes one of the research objectives: take into consideration the student's opinion while evaluating retention.

Then, each team was assigned to administer the survey to freshman and sophomore students in one of the following schools at Philadelphia University (PU); Business Administration (SBA), Architecture (SA), Design and Media (SDM), Health and Science (SSH), Engineering and Textiles (SET). It is important to mention that considering that the

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School of Architecture is the larger one and that School of Liberal Arts does not grant any degree, two teams were assigned to the former school and none was assigned to the later. To conduct the survey, each member of each team randomly selected freshman and sophomore students from each school, resulting in a sample of $n = 474$ surveys collected. Note that the total undergraduate student population at Philadelphia University consists of 2707 students. The average response per question from each school, as well the average across schools (university average) is presented in Table II.

DATA ANALYSIS

Once the information was collected, each team was asked to perform a statistical analysis to identify which factors have a significant effect on retention from the student's point of view.

First, we were interested in identifying which factors affects equally to all university students, and which factors are significantly different depending on the major of study. Therefore, each group performed the *t*-test on the difference on two means with unknown variances to compare the average response of each question from their respective assigned school with the average university response. Furthermore, in order to evaluate if there is a significant difference on the average response between schools, the paired *t*-test between the average of each school and the average university response was performed. The results of these analyses at a level of significance $\alpha = 0.05$ (Table I) suggest that even students from different schools assign different importance to some of the factors studied in this research (number of questions statistically different), on average (paired *t*-test) only students from the Architecture (P -value = $0.032 < \alpha = 0.05$) view retention differently than the average university student.

TABLE I
SIGNIFICANT DIFFERENCES AMONG SCHOOLS

| School | Question # significantly different | Total | <i>P</i> -value paired <i>t</i> -test |
|--------|--|-------|---------------------------------------|
| SA | 2, 5, 6, 10, 16, 18, 26, 30, 31, 33 | 10 | 0.032 |
| SET | 1, 2, 5-10, 14, 17-19, 22, 24, 25, 28, 30-32 | 19 | 0.482 |
| SBA | 1, 2, 9, 10, 16, 17, 21, 26, 27, 31, 32 | 11 | 0.563 |
| SDM | 1-5, 6, 9-10, 19-20, 21-22, 24-26, 31-32 | 17 | 0.396 |
| SSH | 1, 10, 16, 18, 26 | 5 | 0.49 |

However, considering that one of main drawbacks of retention initiatives is the lack of student's involvement and understanding on how they view retention, we can not draw

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conclusions about retention based only on a statistical analysis but in addition a qualitative analysis is required.

TABLE II
RETENTION SURVEY AND DATA COLLECTION

| # | Question | SA | SET | SBA | SDM | SSH | PU |
|----|--|-----|-----|-----|-----|-----|-----|
| 1 | What are you currently in Freshman (1) or Sophomore (2) | 1.4 | 1.5 | 1.2 | 1.5 | 1.3 | 1.4 |
| 2 | Are you female (1) or male (2) | 1.6 | 1.2 | 1.4 | 1.7 | 1.4 | 1.5 |
| 3 | Do you think you will stay at Philadelphia University for your degree (1-5; 5 highest) | 3.9 | 4.2 | 3.8 | 4.4 | 3.9 | 4.0 |
| 4 | Have you considered transferring to other program (1-5; 1-never, 2 few, 3 sometimes, 4 often, 5 several times)? | 2.5 | 2.5 | 2.1 | 1.8 | 2.1 | 2.3 |
| 5 | If you have considered transferring, is it related to your academic performance (1) yes, 2 (no)? | 1.8 | 1.8 | 1.8 | 1.0 | 1.7 | 1.7 |
| 6 | Do you enjoy your experience in the Freshman Year (1-5)? | 4.0 | 3.1 | 3.5 | 3.8 | 3.6 | 3.6 |
| 7 | Do you enjoy your experience in the Freshman Dorm (1-5)? | 3.6 | 2.8 | 3.5 | 3.9 | 3.4 | 3.4 |
| 8 | Rate your transition from High School to College (1-5; 5 successful - 1 failure) | 3.9 | 3.4 | 3.6 | 3.8 | 3.9 | 3.8 |
| 9 | Do you think Freshman Seminar have an impact on retention (1-5; 5 strong 1 no impact)? | 2.5 | 3.0 | 2.2 | 3.1 | 2.5 | 2.7 |
| 10 | Do students take freshman seminar seriously, or they consider it a waste of time (1-5; 5 seriously ,1 waste time)? | 2.5 | 1.5 | 1.8 | 2.6 | 2.6 | 2.2 |
| 11 | Who should mentor frehsmen students upperclassmen (1), faculty (2), both (3)? | 2.6 | 2.6 | 2.7 | 2.7 | 2.7 | 2.6 |
| 12 | Does the size of the class has an impact on student retention (1-5 5; 5 highest impact, 1 no impact)? | 3.4 | 3.5 | 3.5 | 3.8 | 3.7 | 3.5 |
| 13 | Do learning communities promote student interaction and retention (1-5, 5 definitively yes, 1 definitively no)? | 3.5 | 3.7 | 3.8 | 3.4 | 3.4 | 3.5 |
| 14 | How often do you study (1-5; 5 daily, 4 3-4 days, 3 homework and tests, 2 only for tests, 1 rarely)? | 3.4 | 2.8 | 3.4 | 3.1 | 3.5 | 3.2 |
| 15 | Do you find it easier to learn from (1) peers, (2) professors, (3) both? | 2.7 | 2.5 | 2.4 | 2.5 | 2.5 | 2.6 |
| 16 | Are high academic expectations demoralizing to some students (1) or it is expected in college (2) ? | 1.7 | 1.8 | 1.9 | 1.7 | 1.7 | 1.8 |
| 17 | Does students make enough effort to get involved (1), or do they expekt faculty to come to them (2)? | 1.5 | 1.4 | 1.6 | 1.7 | 1.4 | 1.5 |
| 18 | Does peer pressure to party override some students desire to excel in their studies (1=yes, 2 no)? | 1.5 | 1.8 | 1.6 | 1.5 | 1.5 | 1.6 |
| 19 | Do you have friends in your class (1) yes, (2) none, (3) few? | 1.4 | 1.2 | 1.7 | 1.5 | 1.5 | 1.4 |
| 20 | What is more likely to bring you back next year (1) school atmosphere, (2) professors, (3) social life? | 2.0 | 1.9 | 2.2 | 2.0 | 1.8 | 2.0 |
| 21 | Do you think Philadelphia University takes retention seriously (1-5, 5 very seriously, 1 does not care)? | 3.6 | 3.3 | 4.0 | 2.9 | 3.4 | 3.5 |
| 22 | Do you feel accepted in college by your peers (1-5; 5 well accepted, 1 rejected)? | 4.2 | 4.3 | 3.9 | 2.8 | 4.0 | 4.0 |
| 23 | Do you find yourself with something to do on the weekends (1-5; 5 always something to do, 1 nothing to do)? | 3.8 | 3.8 | 3.9 | 3.8 | 3.8 | 3.8 |
| 24 | How often do you go home each month (1-4)? | 2.1 | 2.6 | 2.0 | 1.6 | 2.0 | 2.1 |
| 25 | How much did you know about your major before you entered college (1- nothing, 5 well enough)? | 3.5 | 4.0 | 3.7 | 3.3 | 3.7 | 3.6 |
| 26 | Is Philadelphia University a challenging institution (1-5; 5-strongly agree, 1 strongly disagree)? | 3.8 | 3.3 | 3.1 | 3.2 | 3.8 | 3.6 |
| 27 | Do you consider the major you are studying will be beneficial in the real world (1-5, 5-maximum, 1-minimum)? | 4.3 | 4.3 | 4.0 | 4.2 | 4.4 | 4.3 |
| 28 | What you learn in your major is interesting, and will benefit you later in you life (1-5; 5-maximum, 1 minimum)? | 3.8 | 4.3 | 4.1 | 3.8 | 3.9 | 4.0 |
| 29 | Is it easy to make friends at Philadelphia University (1-5, 5 strongly agree, 1 -strongly disagree)? | 3.8 | 3.8 | 4.0 | 4.0 | 4.0 | 3.9 |
| 30 | Have you change you major at all (1) one, (2) no, (3) more than 1? | 2.0 | 1.7 | 1.9 | 1.9 | 1.8 | 1.9 |
| 31 | Do you use the Learning and Advising Center (1) yes, (2) no? | 1.4 | 1.2 | 1.3 | 1.4 | 1.3 | 1.3 |
| 32 | On average, how many classes a week do you miss (0, 1, 2, 3 - 3 or more)? | 1.2 | 1.5 | 0.8 | 1.5 | 0.5 | 1.1 |
| 33 | Do you often feel stressed about school/social issues (5 very often, 4 often, 3 sometimes, 2 rarely, 1 very few)? | 3.9 | 3.6 | 3.5 | 3.5 | 3.7 | 3.7 |
| 34 | How would you rate your performance in college (1-5; 5 excellent, , 1 poor)? | 3.5 | 3.4 | 3.6 | 3.3 | 3.4 | 3.4 |
| 35 | What is your major? | NA | NA | NA | NA | NA | NA |

Therefore, each group was asked to select what they consider the ten most relevant questions about retention, and to analyze the responses collected, using statistical analysis, and gathering feedback from students, faculty and staff from the school under analysis. A summary of the analysis is as follows:

1. Most of the students at Philadelphia University will stay to complete their degree, average response 4 out of 5.

2. Most of the students have considered only few times changing their major but students from the SA, as well as from the SET have significantly considered more often changing majors. Some of the students attribute it to the fact that architecture and engineering are more challenging majors.

3. The majority of the students allocate time outside the classroom only to do homework and to study for the test (Figure 1). The students conducting this research were

surprised about the low level of hours spent outside the classroom, and recognized the importance of implementing some measures to promote greater amount of studying. This is a critical finding, and if we as educators want to develop life-long learners, it is important that we find means to change the learning process from a lecture-oriented with passive-students to a hands-on, discovery-learning process with active students interacting among them. It is important to point that all the teams listed this question as one of the top three more relevant questions, and all of them expressed they concern about the low level of time allocated to study outside the classroom.

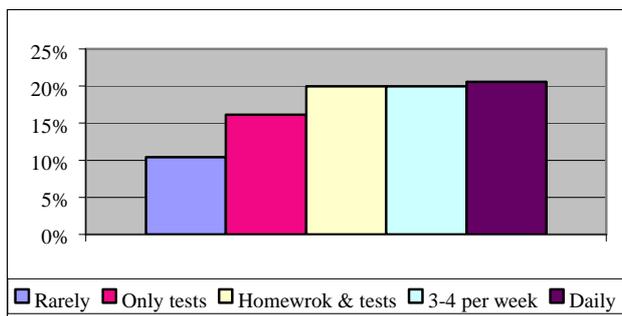


FIGURE 1
STUDENTS' FREQUENCY OF STUDY DISTRIBUTION

4. Another finding that rose students' concern is that students from all majors miss on average at least one class per week. In addition, the frequency distribution shows that 33% of the students miss more than one class per week. Furthermore, students from the SET and the SDM miss on average 50% more classes than the university average. This is a warning signal, and even that we promote that students learn by themselves, class attendance and participation is an important and critical component on students' performance since it is directly related with retention.

5. Questions 6-9 are analyzed altogether since all of them are related to the transition from high school to college. On average, the students consider that they have had a good transition (4 out of 5) from high school to college; however the response from the SET is significantly lower than the university average, which suggests further investigation. It is important to point that the SET could be divided into two major groups: fashion and textile design students, and engineering students. The principal author of this research further investigated this question among the engineering students, and they rated their transition from high school to college above the university average. This is explained due to the multiple initiatives that have been implemented for freshman engineering students such as high level of student involvement, hands-on and team-oriented projects, and student-centered learning communities.

6. The next set of questions (18, 22-24, 29) is related to the social aspect about retention. Overall university students

feel well accepted among peers, which is consistent with the facts that most of them always have something to do on weekends, on average they go home twice per month, and they find relatively easy (score 4 out of 5) to make friends. However, 53% of the students reported that peer pressure to party override some students desire to excel in their studies. This is an issue that affects the student's performance, and consequently retention, and institutions should work closely with the office of student life to monitor it. Some institutions have successfully implemented peer mentors for freshman students, and at that age it is more likely that students would follow the advice of a peer mentor than from an academic/student life advisor. This is reinforced with the responses received from question 11, which indicates that the students prefer to have upperclassman mentors.

7. Then, we analyze the questions that are related to the impact and effectiveness of the Freshman Seminar. The student responses suggest that in general students are not satisfied and benefited (score 2.2 out of 5) with the current format of this courses. However, the SET score significantly higher than the university average, which is explained by the high level of acceptance received by the student's evaluations in the Introduction to Engineering course (effectiveness 4.07/5 and learning experience 4.12/5). This course is all about team-oriented, hands-on projects developed at the state-of-the-art engineering classroom (Figure 2) that integrates theory with experiential learning.



FIGURE 2
INTRODUCTION TO ENGINEERING STUDENTS AT THE STATE-OF-THE-ART ENGINEERING CLASSROOM

8. As mentioned in point 6, a very interesting and important finding of this research is how students consider that they learn more effectively, and who should mentor them (questions 11, 13, and 15). The results of the analysis show that 75% of the respondents consider that both faculty and upperclassmen peers should mentor them, 65% consider that they find easier to learn from faculty and peers, and 88% consider that learning communities promote student interaction and retention. The responses received for these questions are one of the most conclusive findings of this

research considering the consistency and high percentage scored across the three questions, as well as the low variability across the different schools.

9. A very important theme that needs to be carefully monitored since it not only affects retention but also the emotional stability of the students is the stress that many college students experience. The study reports that even the majority of the students agree that the academic expectations are as expected in college, and that Philadelphia University is a challenging institution, 58% of the students often feel stressed about school and social issues. Besides, among the different schools, the students from architecture are significantly more stressed than the average university student, which is partially explained due to the time consuming of the projects that are usually assigned in architecture majors.

10. Finally, the students analyzed two questions directly related to retention. The first one (questions 20) relates to what will bring them back next year, which as illustrated in Figure 3 it shows a balance between school atmosphere, academics and social life. The second one (question 21) is related to the students' perception on how seriously Philadelphia University takes retention, and this is an area that requires improvement since the students clearly indicate that they perceive that the institution just gives an above average importance to retention. These results are consistent with those reported by Tinto [11], who points that most of the retention initiatives do not involve the students' participation and that do not consider their opinion.

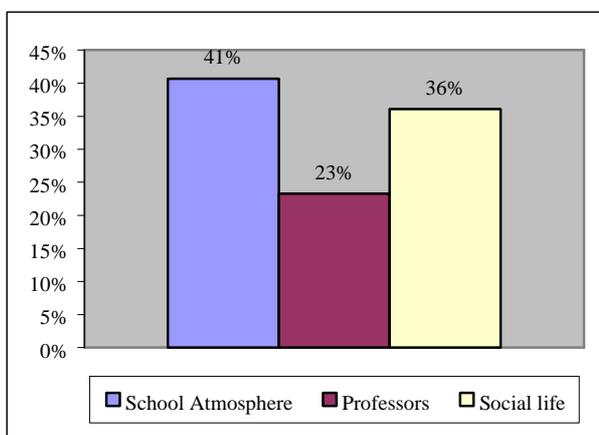


FIGURE 3
WHAT WILL BRING YOU BACK TO SCHOOL NEXT YEAR?

The final part of this research focuses on determining if there is a correlation among the different factors that affect retention that would allow preventing or predicting attrition. As mentioned before, and reported by Takahira *et al* [4], students with better academic skills, and consequently performance are more likely to persist. Therefore, we select the student performance (question 34) as the response

variable, and we perform a multiple regression analysis to evaluate if there is a linear association between the student performance (question 34) and the factors (questions 1-33) that affect retention.

The regression analysis was performed to evaluate if the multiple regression model (1) could provide a good fit to predict the performance of the students (question 34) that belong to school i in terms of the factors (questions 1 – 33) that students estimate affect retention at that school.

$$Y_i = \beta_0 + \sum_{j=1}^{33} \beta_{ij} x_{ij} \quad (1)$$

where,

- Y_i = student performance at school i
- x_{ij} = response to question j from a student that belongs to school i
- j = question number $j, j = 1, 2, \dots, 33$

$$i = \text{school } i, i = \begin{cases} 1 & \text{SA} \\ 2 & \text{SET} \\ 3 & \text{SBA} \\ 4 & \text{SDM} \\ 5 & \text{SSH} \end{cases}$$

The results of the regression analysis (Table III) at a level of significance $\alpha = 0.05$, show that there is a linear association (P -values < 0.05) between the factors that affect retention and the student performance. However, the multiple regression model only provides a good fit ($R^2 > 65\%$) for the SBA, SDM and SSH multiple regression models. The normal probability plots and residual analysis performed for each model do not provide any indications that the models are inadequate. The lack of fit for the SA and SET models could be explained due to the fact that those schools have majors that are substantially different. For example, the SET has the Fashion Design and Mechanical Engineering majors, and the SA has the Architecture and Landscape Architecture majors. Consequently, the students profile may be substantially different but the data used in the analysis contains responses mixed from all the different majors at each school.

TABLE III
RESULTS OF THE LINEAR REGRESSION ANALYSIS

| School | R^2 | P -value |
|--------|-------|------------|
| SA | 45.3 | 0.000 |
| SET | 55.4 | 0.000 |
| SBA | 84.3 | 0.050 |
| SDM | 91.3 | 0.000 |
| SSH | 67.2 | 0.001 |

The linear regression equations are not presented in this paper due to the space limitations but could be provided by requesting them to the corresponding author.

It is important to note that even the regression analysis shows a lack of fit for the SA and the SET models, it doesn't mean that there is not an association between the regressors and the response variables, but that a different model should be investigated.

Finally, we investigated if there is a significant different response between males and females, but the analysis showed that there is no indication that the retention factors affects differently to males and females.

CONCLUSION

The finding of these research show that student participation in retention oriented projects significantly contributes to identify the relevant factors that affect student's retention. Furthermore, student involvement in research projects that affects student performance, such as retention, does not only contribute with the main objective of the project –identify significant factors that affect retention- but it also generate multiple sideline benefits such as:

- Creating learning communities.
- Allowing students to discover by themselves early signals and/or factors that they should observe to persist in college.
- The survey shows that students prefer peer mentors and peer interaction; therefore the survey administered by students more likely represents the true students opinion than a survey administered by faculty, staff or university administration
- Attrition sometimes causes an irreversible effect on the student's future life; therefore it is evident that their input must be considered in any initiative that involves retention. Furthermore, the students have clearly manifested that they are not satisfied with the retention initiatives that have been implemented up to now.

Now, with respect of the findings of the study we can conclude the following:

- Higher education educators need to find means of promoting more active participation of the students outside the classroom, such that they can become life-long learners. However, emphasis must be done in recommending students to attend classes since in it is not possible to become life-long learners without the students' participation in the classroom.
- The results of the linear regression analysis show that there is a correlation between the factors listed in the survey and the students' performance; therefore early signals in those factors could be used to prevent attrition.

- Upperclassmen peer mentors, learning communities, and peer academic mentor are highly accepted and requested by the students, and have proven to be effective methods to improve the students performance both academically and socially; therefore higher education institutions must actively promote these initiatives

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