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Students' Interest in Engineering and Average Final Grade in Mathematics as Factors in Program Retention

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ABSTRACT

Engineering as a degree program requires the students' inclination to mathematics to survive on carrying out various challenges of solving problems more analytically and critically. The study determined the level of interest in the Engineering Program and its correlation to average final grade in College Algebra, Trigonometry and Solid Mensuration as factors of program retention of the Filipino Freshmen engineering students enrolled in the Lyceum of the Philippines University (LPU). It examined the underlying differences between gender, school year of freshmen enrolment, final grades in three basic engineering mathematics and between those students who were retained in LPU to continue their studies and those who left to look for another degree program in other universities. Descriptive type of research method was utilized in the study. Results showed that students who transferred to other universities and/or degree programs have significantly lower level of interest towards engineering and have higher perceived level of difficulty in the program than those students who decided to stay in LPU, and female engineering students have significantly higher view of becoming engineers in the future compared to their male counterparts while the final grades of students who transferred in other universities obtained significantly lower final grades in College Algebra and Trigonometry.

KEYWORDS

Engineering, mathematics, interest, academic performance, gender difference, descriptive design, Lyceum of the Philippines University, Batangas City, Philippines

INTRODUCTION

The problem-solving skills of students in Mathematics is an essential competence that drives them to pursue engineering together with their interest to become engineers in the future. Mathematics is a significant topic supporting a large number of engineering courses and consequently, it is important for engineering students to hold a strong mathematics fundamental knowledge that can keep their motivation for equitable progress of their engineering programmes (Othman et al., 2012).Mathematics is a prime constituent and infrastructure of the education of engineering students (Kashefi, 2012). There are some students that need more motivation to see the beauty of math (Limjuco, 2012). In this study, the problem of retaining qualified students in the College of Engineering of Lyceum of the Philippines University – Batangas City tries to correlate their final grades in basic Engineering Mathematics with the interest of the students towards the program.

As a service-oriented university, it is important to provide satisfaction to the customers especially in helping them accomplish the program to the university where they have started. Therefore, helping them retain in the engineering program is one of the hardest task of all faculty members in the College of Engineering. Student retention involves the way students enrol, stay enrolled, complete their degrees, or drop out at a specific higher education institution (Leone &Tian, 2009). Factors generally recognized as influences on student retention rates cross a broad array of individual and institutional characteristics (Webster & Showers, 2011).

Engineering is considered one of the hardest degree programs in college considering its number of years to finish which is one year longer than the usual four-year degree program; the nature of the courses on engineering mathematics and sciences are different from the subjective way of developing knowledge and skills of other programs in arts and business professions.

Differences in the responses of the engineering students were examined when they were grouped according to their gender, school year of freshmen enrolment and the interest of those students who stayed in the engineering program and those who transferred and shifted to another school and degree.

Gender was considered an important variable in the study to identify the difference in the level of interest of males and females in the engineering program and how

would it help to explain their performance in mathematics though female engineering students are outnumbered by the male students in LPU with almost one-third. Reasons for the under-representation have been explored including differential socialization and aspirations along gender lines, which is related to differential attraction to engineering in general and more specifically to the various fields of engineering, as well as different educational and professional climates for the genders in these various disciplines (Hartman & Hartman, 2009).

FRAMEWORK

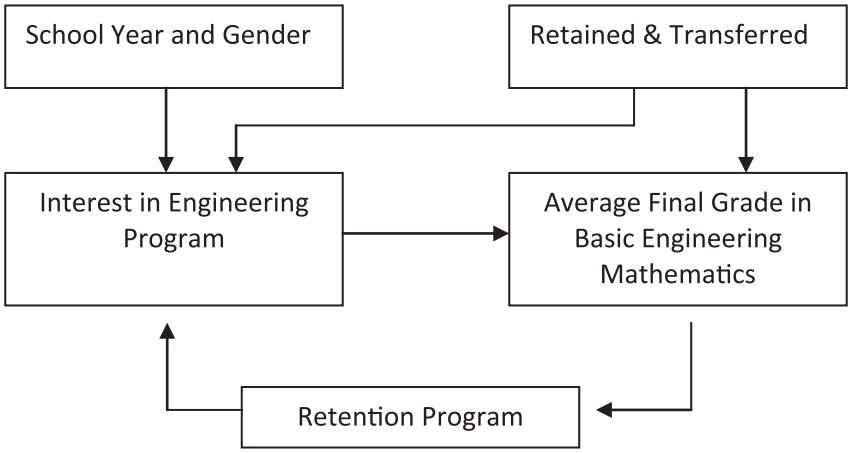

Figure 1. Conceptual Framework

Figure 1 illustrates the conceptual framework of the present study. According to Tinto (2007) that when the issue of student retention first appeared on the higher educational radar screen, now some 40 years ago, student attrition was typically viewed through the lends of psychology. Student retention or the lack thereof was seen as the reflection of individual attributes, skills, and motivation. Students who did not stay were thought to be less able, less motivated, and less willing to defer the benefits that college graduation was believed to bestow.

Interest is an intrinsic motivational factor that stimulates the enthusiasm of a person to perform better or more than what is expected of him to accomplish. Determining the motives towards engineering degree program of the Filipino freshman students enrolled in the engineering degree program in one of the private universities in the Philippines is necessary in understanding the result of their average final grade in College Algebra, Trigonometry and Solid Mensuration. The subject of math-

ematics is important as a prerequisite and requirement as most topics in engineering courses widely employ these fundamentals (Kipli, 2012). Abdullah (2013) said that Mathematics has been said as the most important foundation in engineers' life. One of the student outcomes (SO) should be required for students to accomplish their academic pursuit is the ability to apply knowledge of mathematics and science to solve engineering problems. Maintaining the balance between the activities of the academic program and students services is a means of retaining the students.

OBJECTIVES OF THE STUDY

This study determined the level of interest in the Engineering Program and its correlation to average final grade in College Algebra, Trigonometry and Solid Mensuration as factors of program retention of the Filipino first year engineering students enrolled in the Lyceum of the Philippines University (LPU) with an aim of identifying the underlying differences between gender, school year of the first year students enrolment, final grades in three basic engineering mathematics and between those students who retained in LPU to continue their studies and those who left to look for another degree program in other universities.

METHODOLOGY

This study utilized a descriptive type of quantitative research method. In quantitative descriptive research, it involved the collections of information that can be tabulated along a continuum in numerical form or it can describe categories of information (AECT, 2001).

Participants

The participants were 91 first year students enrolled during the SY 2011-2012 and 92 first year students during SY 2012-2013. This study included the total population of the Engineering students in the first year level from two consecutive school years in the College of Engineering of Lyceum of the Philippines University.

Data Collection Instruments

A researcher-made survey instrument and documentary analysis were used to gather all the data needed to analyze the problem. The survey instrument used to determine the level of interest of engineering students in engineering degree program

was tested the reliability using the test-retest method to the student–respondents not included in the study. The respondents were offered five-point Likert Scale.

The researcher administered the pilot testing personally to answer some questions of the students on terms and statements which they found confusing. Rephrasing and restating the questions were done in the instrument to make it more suitable to the level of respondents' understanding. After a week, the researcher asked the same group to answer again the same set of questions. The computed 0.85 Cronbach's alpha signified that the questionnaire was acceptable based on "rule of thumb" which lies within the range of "Good" (George and Mallery, 2003). The final grades of the students in College Algebra, Trigonometry and Solid Mensuration were obtained from the University Registrar's Office.

Procedure

The survey questionnaires were administered to the first year engineering students for two consecutive school years; the first one was in June during SY 2011-2012 and the other one was in June during SY 2012-2013. All students were oriented regarding the purpose of this study and their answers were treated with strict confidentiality. They were also given five minutes to answer the ten questions regarding their interest in the engineering program as well as rating the degree of difficulty of engineering from 1 as very easy and 10 as very hard.

Data Analysis

The data were collected, classified, tabulated and coded for the analysis and interpretation. The following statistical tools were applied in the data obtained from the instrument used in the survey, including the frequency count, percentage, weighted mean, Cronbach–alpha for testing the reliability of the instrument, Pearson–Product Moment correlation Coefficient was used to determine the relationship between the interest of the students and their finals grades in the identified courses while Independent Sample T-test was used to determine the differences between gender, school year of the first year students enrolment and those students who retained in the program and those who transferred and/or shifted.

RESULTS AND DISCUSSION

Table 1. Frequency distribution of engineering students who shifted/transferred and retained in the engineering program for two consecutive years

Category	2012-2013		2011-2012	
	F	%	F	%
Shifted/Transferred	21	22.83	37	40.66
Retained	71	77.17	54	59.34
Total	92	100	91	100

About 22.83 percent of the engineering students already transferred to another school and/or shifted to another degree program after one year while 37 or 40.66 percent left the College of Engineering from the first year students batch 2011-2012 after two years. Only 71 students or 77.17 percent left to the first year students while 54 or 59.34 percent left to the Second year students before the end of SY 2012-2013. The first year of college has been identified as the most critical for student success. It is no secret that a majority of students choose to leave college during their first year of study. Most of the first year students leave within the first two years of study. Understanding why students leave college involves a complex number of factors (Gilliam & Kritsonis; Craig, 2011). These students leave the engineering department voluntarily. They were given the freedom to transfer and/or move to another degree program where they feel they can be more successful in terms of acquiring knowledge and skills not only obtaining passing or high grades.

Both group of respondents strongly agreed that they want to become engineers someday but those students who shifted/transferred moderately agreed that they are aiming to be included in the Top Engineering Students' List or Dean's List with the least weighted mean score while those who stayed in the program have also the same answer that obtained the least score. This signifies that students where very much oriented regarding the nature of engineering when it comes to academic performance. According to the study conducted by Bouvier and Connors (2011), students had a strong interest in, and awareness of, the importance of science, technology, engineering and mathematics subjects and career possibilities. Students indicated they agreed or strongly agreed that engineering is a very important profession and engineers do lots of different and interesting things. Most of them believed that getting higher remarks in engineering is very hard to achieve.

Table 2. Comparison result in the interest in engineering program between students who retained in the program and those who shifted/transferred

Interest in the Engineering Program	Transferred N=58		Retained N = 125		t-value	Sig.
	WM (SD)	VI	WM(SD)	VI		
1. I believe, I can finish this course.	4.16 (0.79)	A	4.34(0.79)	A	-1.437	.152
2. I want to become an engineer someday.	4.47(0.82)	SA	4.60(0.72)	SA	-1.125	.262
3. I have no second thought of taking up engineering.	3.59(0.94)	A	3.73(0.89)	A	-.984	.326
4. I am confident that I can handle all the challenges and difficulties of engineering.	3.76(0.80)	A	3.95(0.82)	A	-1.493	.137
5. I will devote most of my time in studying my lessons.	3.78(0.84)	A	4.10(0.78)	A	-2.583	**.011***
6. I am aiming to be included in the Top Engineering Students' List or Dean's Lister.	3.45(1.03)	MA	3.70(0.93)	A	-1.669	.097
7. I can balance my time between my academic subjects and university/college activities.	3.83(0.92)	A	3.87(0.84)	A	-.322	.748
8. I will prove to myself that I really deserved to take up engineering.	4.09(0.88)	A	4.39(0.82)	A	-2.286	.023*
9. I will take all my academic subjects seriously to obtain high grades.	4.05(0.85)	A	4.38(0.74)	A	-2.640	.009**
10. I am ready to face the challenges of engineering no matter how hard it is.	4.00(0.88)	A	4.35(0.71)	A	-2.888	.004**
Composite Mean	**3.92(0.65)**	**A**	**4.14(0.56)**	**A**	**-2.403**	**.017***

* p-value< 0.05 *WM – Weighted Mean; VI – Verbal Interpretation; SD – Standard Deviation* ** p-value< 0.01

Those who stayed in the engineering program have significantly higher interest in pursuing the program compared with the interest of those who already left the university and transferred to another school and degree program. Those who stayed in the program have significantly higher interest in devoting most of their time in

studying their lessons; proving to themselves that they really deserved to take up engineering; and taking all their academic subjects seriously to obtain high grades. It is worthy to note that those students who stayed in engineering have significantly higher degree of readiness to face the challenges of engineering.

Table 3. Comparative result of the students' interest towards engineering program between two school years as well as between genders

Interest	School Year		Difference		Gender		Difference	
	2012-2013 (SD) N= 92	2011-2012 (SD) N = 91	t-value	Sig. (2-tailed)	Male (SD) N = 136	Female (SD) 47	t-value	Sig. (2-tailed)
Interest1	4.24 (0.84)	4.32 (0.74)	-.677	.500	4.22 (0.82)	4.45 (0.69)	-1.692	.092
Interest2	4.52 (0.75)	4.59 (0.76)	-.643	.521	4.47 (0.82)	4.81 (0.45)	-2.698	**.008****
Interest3	3.71 (0.96)	3.66 (0.86)	.351	.726	3.66 (0.88)	3.74 (0.99)	-.539	.590
Interest4	3.78 (0.85)	4.00 (0.77)	-1.808	.072	3.85 (0.83)	4.00 (0.78)	-1.063	.289
Interest5	4.05 (0.83)	3.95 (0.79)	.910	.364	3.92 (0.81)	4.23 (0.79)	-2.320	**.021***
Interest6	3.64 (1.01)	3.60 (0.93)	.257	.798	3.55 (0.98)	3.83 (0.92)	-1.706	.090
Interest7	3.88 (.086)	3.84 (0.87)	.353	.725	3.80 (0.88)	4.02 (0.79)	-1.506	.134
Interest8	4.28 (0.91)	4.31 (0.80)	-.199	.843	4.28 (0.86)	4.34 (0.84)	-.422	.673
Interest9	4.32 (0.78)	4.23 (0.79)	.726	.469	4.23 (0.79)	4.40 (0.77)	-1.329	.185
Interest10	4.33 (0.74)	4.15 (0.82)	1.494	.137	4.21 (0.79)	4.34 (0.76)	-1.016	.311
Composite	4.08 (0.63)	4.06 (0.57)	.114	.909	4.02 (0.62)	4.22 (0.53)	-1.965	.051

* p-value< 0.05 ** p-value< 0.01

There is no significant difference in the level of interest in the engineering program between the first year engineering students enrolled during SY 2011-2012 and SY 2012-2013. This implies that both groups of students from two different school years have possibly obtained higher and lower scores in the ten indicators of interest towards the program.

Engineering was a field of study that remained within the male domain for a long time (Zacaj, 2010). However, in terms of gender, female engineering students have significantly higher view of becoming engineers in the future and devoting most of their time in studying their lessons compared with their male counterparts. Liberal feminists believe that women have the same potential of becoming scientists as men, and once all barriers that are keeping women from entering and remaining in science are removed, women will achieve the same participation in science and engineering as in all other fields (Rosser, 1998; Zacaj, 2010).

Table 4. Comparative results of the perceived degree of difficulty between category, year and gender

Degree of Difficulty	**Mean (SD)**		**t-value**	**Sig.**
Category	**Retained**	**Transferred**		
	6.54 (1.96)	7.31 (1.81)	**2.25**	**0.012***
Year	**2012-2013**	**2011-2012**		
	6.33 (1.82)	7.25 (1.95)	**-3.319**	**0.001****
Gender	**Male**	**Female**		
	6.69(1.93)	7.04(1.94)	-1.049	.296

** p-value< 0.05*

*** p-value< 0.01*

When it comes to the degree of difficulty, those students who left the university to transfer and shift to another program have significantly higher perceived level of difficulty in engineering than those who pursued the program. In terms of different groups from two school years, first year students from SY 2011-2012 have significantly higher level of perceived difficulty of engineering while gender has no significant difference in terms of level of difficulty. This implies that there is a little mean variation in responses between genders which is not enough to consider the difference. This implies that those students who moved to another degree found engineering as significantly difficult.

In the study conducted by the group of Stevens et al., (2007), they emphasized that there is a meritocracy of difficulty in engineering because the school work is much more difficult and competitive than that of students in other departments. They deserve the comfortable material existence an engineering degree will provide and a view of engineering as lifestyle because the expectation that an engineering degree will result in a comfortable material existence as pervasive beliefs among engineering students.

Table 5. Difference between the final grades in basic Engineering Mathematics of two groups of respondents

Basic Engineering Math	Transferred (SD)	Retained (SD)	t-value	Sig.
Trigonometry	76.48	80.56	-3.448	0.001**
College Algebra	73.60	79.12	-3.163	0.002**
Solid Mensuration	72.28	73.72	-.138	0.89

** p-value< 0.05; ** p-value < 0.01*

Students who decided to leave the engineering program obtained significantly lower final grades in Trigonometry and College Algebra compared with those students who remained in the program while their finals grades in Solid Mensuration do not significantly differ. This signifies that their final grades in two basic engineering mathematics are considered essential factors for them to transfer to another school or shift to another degree program where they can obtain passing or higher grades. While it is true that the capacity to solve problems is one of the important skills now being promoted at tertiary level, yet many learners still found mathematics difficult (Herrera, 2011).

Table 6(a). Interest in the engineering program as a predictor of the average final grade in engineering mathematics (model summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.417(a)	.174	.169	.68333
2	.471(b)	.222	.212	.66535
3	.491(c)	.241	.227	.65899

a Predictors: (Constant), Interest 1; b Predictors: (Constant), Interest 1, Interest 6
c Predictors: (Constant), Interest 1, Interest 6, Interest 9

There is a 17.4 percent confidence when the interest of the students in believing that they could finish the engineering course was taken as a single predictor. They can possibly obtain their average final grade in mathematics, but if the indicator of interest number 6 which is aiming to be included in the Top Engineering Students' List or Dean's List was combined to interest number 1, there is a 22.2 percent guarantee. Meanwhile, if these two indicators were combined to indicator of interest number 9 which is the willingness to take all academic subjects seriously to obtain high grades, there is a 24.1 percent chance of obtaining what they have achieved in the three mathematics subjects as their final grade.

Table 6 (b). Interest in the engineering program as a predictor of the average final grade in engineering mathematics (analysis of variance)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.934	1	15.934	34.124	.000(a)
	Residual	75.643	162	.467		
	Total	91.577	163			
2	Regression	20.304	2	10.152	22.933	.000(b)
	Residual	71.273	161	.443		
	Total	91.577	163			
3	Regression	22.094	3	7.365	16.959	.000(c)
	Residual	69.483	160	.434		
	Total	91.577	163			

a Predictors: (Constant), Interest 1; b Predictors: (Constant), Interest 1, Interest 6
c Predictors: (Constant), Interest 1, Interest 6, Interest 9; d Dependent Variable: Average Final Grade

This signifies that engineering students who want to pursue the engineering program must strongly believe that they could really finish the program with much confidence of aiming to be included in the Top Engineering list while at the same time, they have to assume full responsibility of taking seriously all their courses to attain the grades they really wanted to achieve. High ability students are more confident and have a better attitude towards solving mathematics problems than the low and average ability students (Hortillosa, 2013)

CONCLUSIONS

The foundation of knowledge in basic engineering mathematics must be strengthened based on the factors that are intrinsically owned by the students like their interest towards the engineering program. Many teachers and students think that mathematics can only be taught in a straightforward manner and this universal belief might be the cause why a lot of mathematics learners still are unable to appreciate the subject because obviously their preconceived notion that mathematics is difficult is never addressed (Limjuco, 2012). Faculty members handling mathematics courses have the direct contact with the students, therefore, they have full responsibility to encourage and motivate the students to aspire for high grades through developing

good study habits that would help them later adjust to more rigorous professional courses in higher years of engineering.

The theory of Tinto supports the conclusion of the study that shows low interest or motivation of the students to excel and face the challenges of engineering are those who shifted and transferred to another degree program. Therefore, those engineering students who retained in the program must realize the value of perseverance and commitment towards their work. The habits they usually practiced during college years would also be their way of life when they become future professionals in their respective fields of specialization. Developing the students with the right attitude towards work as early as first year would prepare them to a more solid foundation of personality that they could be used as strong defence from all the challenges of engineering program.

RECOMMENDATIONS

Implementation of retention program for the College of Engineering would prevent students from leaving the engineering program. Enrolees must be given proper advice by the Guidance Counsellors before they enrolled in the engineering program. The difference between engineering and the other programs should be made clear. They should recognize the value of time they have to spend for five years in finishing their studies. Open communication through the use of consultation hours of the faculty members would motivate the students to exert more effort in studying their lessons of concern and consideration being given to them by their teachers.

It should also be cleared to the parents what really makes the interest of their children, not because engineering is a very attractive profession but if they will assess properly and if they will give due consideration to the mental and emotional capability of their children in pursuing engineering, they would have a clear image of what will happen one year or two years after the enrolment of the students in the engineering program. Too many failing and incomplete remarks as well as unofficially dropped courses in class cards would be a sign for students to decide whether they wanted to continue engineering or better move to another degree program.

The College of Engineering should provide student activities that would enhance the mathematical skills of the students as well as their interest and enthusiasm especially the male students to finish the engineering program without transferring to other universities. Giving the students with the right treatment and guidance would make them remain secured and loyal to the academic institution where they have started.

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