Motivation, Self-Efficacy and Anxiety in Learning Engineering Fundamentals among Year 1 Students at Southern Institute of Technology

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1.Introduction

1.1 Background of the Study

The constructs of motivation, self-efficacy, and anxiety have always been stressed in the academe. In view of this, psychologists and educators have long considered those three as predictors of students' achievement and learning which in turn contribute considerably to students' performance (Graham & Weiner, 1996; Bandura & Locke, 2003; Pajares, 1996). According to Soleymani and Rekabdar (2016), the three constructs are significant in understanding mathematics achievement. Motivation consists of the internal and external factors that stimulate the desire to attain a goal, while the belief in one's capabilities to carry out, organize and perform a task successfully refers to self-efficacy. Anxiety refers to a state of tension and anxiety that meddles with the operation of numbers and the solving of mathematical problems in ordinary life and academic situations (Aschaft, 2002). As tertiary tutors respond to the need for promoting mathematics literacy, the substantial role of learners' self-efficacy, motivation and anxiety has received increased attention (Hannula, 2006; Pape & Smith, 2002).

Gurefe and Bakalim (2018) cited a number of studies (i.e., Aydin & Keskin, 2017; Maloney, Levine & Beilock, 2016; Borich, 2014; Cakiroglu & Isikal, 2009; Nicolaou & Philippou, 2007) showing that affective factors are just as important as cognitive factors in learning, and influence mathematics learning. May (2009) found that the mathematics achievements and performances of college students are often influenced by their mathematics self-efficacy and anxiety.

Results of studies from various academic domains have shown that students' self-efficacy affect their academic attitude and performance toward (Ayoobiyan & Soleimani, 2015). According to Ersanli (2015 as cited in Torres & Alieto, 2019), scholars like Pajares (1996), Jackson (2002), Ching (2002), Margolis and McCabe (2003) concur with the idea that individuals who rate themselves capable on a given task will probably engage more than when they do not feel themselves competent enough. In an earlier study, Liu and Koirala (2009) probed on the association between mathematics self-efficacy and mathematics achievement of high school students. Correlation and linear regression analysis results indicated that mathematics self-efficacy and mathematics achievement were significantly related.

Cates and Rhymer (2003), in their study involving tertiary students enrolled in a mathematics course, found that those with higher levels of mathematics anxiety had significantly lower computational fluency in all aspects of mathematical computation. This lower level of fluency in turn decreases students' achievements in mathematics and possibly contributes to negative behaviour toward the subject. In a more recent study, Alkan (2011 as cited in Gurefe & Bakalim, 2018) found that learners with low mathematics anxiety are more successful in mathematics compared to others, while learners with high mathematics anxiety are less successful.

Though there are studies showing the effects of the three constructs to learners' academic achievement, there is a dearth of research studies that described how those three psychological constructs are manifested among learners. It is also of significant interest to explore how learners' variables such as their academic achievement as measured in terms of

their class standing in mathematics classes during high school and scores in Engineering Fundamentals and the number of Engineering courses they have completed relate to their motivation, self-efficacy and anxiety to learn the subject. Since mathematics self-efficacy, motivation, and anxiety affect the achievements of students in Engineering courses, it is vital to understand how the three relate to each other since past studies focused on exploring and reporting the three constructs separately. Lastly, there is a limited study to date that focused on a specific subject and most centred on general subjects. Hence, this study.

1.2 Research Questions:

a. How may the participants' motivation, self-efficacy and anxiety in learning Engineering Fundamentals be described?

b. Is there a relationship between participants' motivation, self-efficacy and anxiety to their:

b.1 class standing in Mathematics class during their high school;

b.2 Progress Test I Score in Engineering Fundamentals;

b.3 Score in their most recent assessment in Engineering Fundamentals; and

b.4 Number of Engineering subjects completed

c. Is there a relationship among the participants' motivation, self-efficacy and anxiety in learning Engineering Fundamentals?

1.3 Hypothesis

a. There is no relationship between participants' motivation, self-efficacy and anxiety to their:

a.1 class standing in Mathematics class during their high school;

a.2 Progress Test I Score in Engineering Fundamentals;

a.3 Score in their most recent assessment in Engineering Fundamentals; and

a.4 Number of Engineering subjects completed

b. There is no relationship among the participants' motivation, self-efficacy and anxiety in learning Engineering Fundamentals.

2. METHODOLOGY

2.1 Research Design

The study used the quantitative descriptive research design. Descriptive research was used since the study aims to describe the participants' learning motivation, self-efficacy and anxiety in Engineering Fundamentals course. It also describes pattern of interaction on participants' categories of information such as their class standing in mathematics class during high school, Progress test I score in Engineering Fundamentals, score in their most recent assessment in Engineering Fundamentals and number of Engineering subjects completed to their levels of motivation, self-efficacy and anxiety. Finally, it describes the interaction among the three constructs – motivation, self-efficacy and anxiety.

2.2 Participants

A total of 30 students enrolled in Engineering Fundamentals from Southern Institute of Technology participated in the study. From among the participants, 19 (63.33%) are international students and 11 (36.70%) are Kiwi or domestic students. International students come from countries such as Brazil, China, India, Indonesia, Kazakhstan, Korea, Philippines, Russia, and Sri Lanka. The participants' ages range are from 16 to 35 years old. Nine of the

participants belong to 16 -20 years old and 25 – 30 years old. Seven belong to 21-25 years old and five belong to 31-35 years old.

2.3 Research Instruments

2.3.1 Motivation, Self-Efficacy, Anxiety Scales, Reliability and Validity of the Instruments, and Data Gathering

The questionnaires for the Engineering Fundamentals motivation and self-efficacy were patterned from the motivation, self-efficacy and anxiety surveys administered by Clement and Kruidenier (1983), Clement et.al (1994), Ely (1986) and May (2009). To establish the scales' validity, they were presented to a registered psychometrician in the Philippines, who commented on the structure and contents of the scales. All the suggestions were incorporated before coming up with the final version of the questionnaire. Meanwhile, to determine the reliability of the two scales, they were pilot tested to 20 non-participants. The answers were analysed using Cronbach's alpha that resulted in high value for motivation scale (α = .921) self-efficacy scale (α =.891) and anxiety (α = .842). Prior to the distribution of the questionnaires, the researcher sought permission, through a formal letter. The scales were administered to 20 students enrolled in Engineering course.

2.3.2 Data Analysis

Responses in the motivation scale were tabulated and coded as follows: 4 = Strongly Agree; 3 = Agree; 2 = Disagree; 1 = Strongly Disagree. The computed means were interpreted as follows: 3.42 - 4.00, Strongly Agree; 2.62 - 3.41, Agree;1.80 – 2.61, Disagree; 1.00 - 1.79, Strongly Disagree. Responses in the self-efficacy and anxiety scales were tabulated and coded as follows: 4 = Always; 3 = Often; 2 = Seldom; 1 = Never. The computed mean scores were interpreted as follows: 3.42 - 4.00, Always; 2.62 - 3.41, Often;1.80 – 2.61, Seldom; 1.00 - 1.79, Never. To answer the first research question, descriptive statistics such as mean and standard deviation was used. For the second and third research questions, Pearson-r was used.

3. RESULTS AND DISCUSSION

This part reports the participants' levels of motivation, self-efficacy and anxiety in learning Engineering Fundamentals. Likewise, it presents and discusses the results as regards the relationship between the three constructs to participants' academic variables. Finally, it shows and interprets findings as regards the interrelationship among the three constructs.

3.1 Motivation, Self-Efficacy and Anxiety in Learning Engineering Fundamentals

Presented in Table 1 is the participants' motivation in learning the course, Engineering Fundamentals. The overall weighted mean of the nine items pertaining to motivation is 3.77 described as "Strongly Agree". This means that participants have strong level of agreement as regards their perceived importance of learning the course. All the statements received a verbal description of "strongly agree". Of the nine items, Item 1 obtained the highest mean of 3.90 followed by Items 3, 6 and 9 all with mean scores of 3.80. The foregoing items that obtained the highest mean scores pertain to extrinsic motivation, which implies that the reasons the participants have for learning the course have to do with the external rewards that they may get out of it. These external rewards include the development of their careers as engineers (Item 1) and completion of degree (Item 3). Meanwhile, participants also reported that they 'strongly agree' on the premise that they get pleasure from learning the subject, which falls in intrinsic motivation. From the obtained data, it can be opined that the participants have high level of both the intrinsic and extrinsic motivation in learning the subjects, although the mean scores of the items that fall in the former are slightly higher compared with the latter.

Table 1: Participants' Motivation in Learning Engineering Fundamentals

Statements	Mean	Mean Description
1. The skills that I am acquiring from the subject, Engineering Fundamentals, will be useful in developing my career as engineer.	3.90	Strongly Agree
2. Through this subject, I can learn how to formulate and solve problems directly related to engineering.	3.77	Strongly Agree
3. The subject provides me learning activities that will be helpful for me to complete engineering degree.	3.80	Strongly Agree
4. The ability to communicate effectively by using mathematical arguments is an important skill to develop.	3.63	Strongly Agree
5. The formal and rigorous aspects of the subject are important in my future career as engineer.	3.70	Strongly Agree
6. I can get pleasure from learning the subject, Engineering Fundamentals.	3.80	Strongly Agree
7. Knowledge and skills in this subject can help me to perform well in other subjects.	3.73	Strongly Agree
8. I gain recognition when I do well in the subject, Engineering Fundamentals.	3.67	Strongly Agree
9. Skills in the subject will help me to improve my life in the future.	3.80	Strongly Agree
Average	**3.77**	**Strongly Agree**

Summarized in Table 2 is the participants' self-efficacy in learning Engineering Fundamentals. The overall weighted mean for the 11 items is 3.32 described as "always". This coincides with the findings of Parsons and Gonzalez (2018) that students in the Mathematics-Science Program had the highest mathematics self-efficacy. The item that obtained the highest mean is Item 10, followed by Items 5, 7 and 1. From the foregoing result, it can be deduced that since the participants are engineering students, they have already developed the belief that they can perform the tasks related to the subject ranging from learning the subject, understanding the contents and discussion in the class, completing the assignments and asking questions related to the subject. Meanwhile, the items that registered the lowest mean scores are Items 8, 4, 6 and 9, all of which have verbal description of "often". From the latter, it can be opined that participants have not yet fully-developed the belief that they can always think of themselves like a mathematician, perform well on a test in their subject, and considered themselves who are good in the subject. This can be attributed to the fact that since they are still on their Year 1, they are still starting to gain full mastery of the courses in their curriculum.

Table 2: Participants' Self-Efficacy in Learning Engineering Fundamentals

Statements	Mean	Mean Description
1. I feel confident enough to ask questions in my Engineering Fundamentals class.	3.50	Always
2. I believe that I can get an excellent grade in the subject.	3.37	Always
3. I feel that I will be able to do well in future mathematics course.	3.27	Always
4. I believe I can do well on a test in the subject Engineering Fundamentals.	3.20	Often

5. I believe that I can complete all the assignments in the subject, Engineering Fundamentals.	3.53	Always
6. I believe that I am the kind of person who is good at the subject, Engineering Fundamentals.	3.23	Often
7. I believe that I understand the contents and discussion in the class.	3.52	Always
8. I believe I can think like a mathematician.	2.90	Often
9. I feel confident when using mathematics outside of school.	3.07	Often
10. I believe that I can learn well in the subject.	3.60	Always
11. I feel confident when taking test in the subject, Engineering Fundamentals.	3.33	Always
Average	**3.32**	**Always**

Shown in Table 3 is the summary of the participants' anxiety in learning the course. The overall weighted mean of the 12 items is 1.63 described as never. Of the 12 items, only Items 7, 8 and 10 obtained mean scores with verbal description of "seldom", while the remaining items got mean scores with verbal description of "never". Based on their reporting, the participants seldom feel anxious during the subject though they feel that they are well-prepared of it. They also seldom feel stress while working on their homework in the subject and they too seldom worry that they will not be able to get good grade in the subject. This is also consistent with the findings of Parsons and Gonzalez (2018) that students in Mathematics-Science program had the lowest mathematics anxiety. The results imply that the Year 1 students have already conquered their anxiety towards learning the subject and it is seldom that they become anxious while taking the course.

Table 3: Participants' Anxiety in Learning Engineering Fundamentals

Statements	Mean	Mean Description
1. I feel like not going to my Engineering Fundamentals' class	1.27	Never
2. I get tense when I prepare for a test in my Engineering Fundamentals class.	1.70	Never
3. I get nervous when I have to use mathematics outside of school.	1.57	Never
4. I get nervous when asking questions in class.	1.43	Never
5. When I am on my way to my Engineering Fundamentals' class, I feel very uncertain and tense.	1.40	Never
6. I feel more tense and nervous in my Engineering Fundamentals' class than in my other classes.	1.50	Never
7. Even if I am well prepared for the class, I feel anxious about it.	1.93	Seldom
8. Working on homework in the subject, Engineering Fundamentals, is stressful for me.	1.93	Seldom
9. I worry that I will not be able to use the skills and knowledge that I will learn in this subject.	1.73	Never
10. I worry that I will not be able to get a good grade in the subject, Engineering Fundamentals.	2.24	Seldom
11. I feel stressed when listening to my tutor in this subject.	1.27	Never
12. I am afraid to give an incorrect answer during my class in Engineering Fundamentals.	1.53	Never
Average	**1.63**	**Never**

3.2 Relationship between Engineering Fundamentals learning motivation, self-efficacy and anxiety to participants' academic variables

Table 4 presents the correlation results among the three constructs and academic variables. Results reveal that motivation and self-efficacy are positively related to participants' scores in Progress Test I in Engineering Fundamentals. This means that the higher their scores in the Progress Test, the more they agree on the statements as regards their perceived importance or reasons of learning the subject and the more frequent they believe themselves able to perform the tasks related to the course. Meanwhile, only self-efficacy has established positive relationship with the participants' class standing in Mathematics class during high school. This means that the higher their class standing, the more they believe in themselves that they are capable of performing the course-related tasks.

Table 4: Relationship between the three constructs to Class Standing in Mathematics in High School, Progress Test I Score, Assessment Score in Engineering Fundamentals and Number of Engineering Subjects Taken

	Class Standing in Mathematics in High School		**Progress Test I Score in Engineering Fundamentals**		**Assessment Score in Engineering Fundamentals**		**Number of Engineering Subjects Taken**	
	Correlation Coefficient	P-value	Correlation Coefficient	P-value	Correlation Coefficient	P-value	Correlation Coefficient	P-value
Motivation	0.206	0.283	.406*	0.026	0.139	0.464	-0.081	0.675
Self-Efficacy	.514**	0.004	.375*	0.041	0.354	0.055	-0.305	0.107
Anxiety	-.412*	0.026	-.594**	0.001	-.477**	0.008	.382*	0.041

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Anxiety in learning the subject has established negative correlation with the class standing in Mathematics during high school, Progress Test I and assessment scores in Engineering Fundamentals. This implies that the higher their class standing in high school mathematics, scores in Progress Test I and assessment in the subject, the less frequent they become anxious while taking the course. Meanwhile, anxiety has established positive relationship with the number of Engineering subjects taken which implies that the more engineering subjects the participants have taken, there is a higher tendency that they become anxious towards learning the subject.

3.3 Relationship among Engineering Fundamentals' learning motivation, self-efficacy and anxiety

Correlation results among motivation, self-efficacy and anxiety are presented in Table 5. Motivation and self-efficacy are positively related (r = .669**). Thus, the alternate hypothesis was accepted and the null hypothesis was rejected. The significant positive relationship between the motivation and self-efficacy validated Piniel and Osizer (2013), Bandura (1977, 1986, 1995 in Bandura, 1997), Basco and Han's (2016), and Torres and Alieto's (2019) findings that motivation and self-efficacy are related constructs with the latter having a strong effect on the former. Meanwhile, negative relationship was established between motivation and anxiety (r - .835**) and self-efficacy and anxiety (r = -.728**).

Table 5: Correlation among motivation, self-efficacy and anxiety

	Pearson Correlation	Sig. (2-tailed)
Motivation and Self-Efficacy	.669**	<0.001
Motivation and Anxiety	-.835**	<0.001
Self-Efficacy and Anxiety	-.728**	<0.001

4. CONCLUSION

Results on the learning motivation can be seen as an advantage on the part of course tutors because they no longer need to emphasize to their students the importance of learning the course, since students have already a clear framework on their mind as to why there is a need to learn and master the subject. However, learners also need to develop within themselves a high level of integrative motivation and not only that of instrumental motivation. This is in relation to what Gardner and Lambert (1972 as cited in Torres & Alieto, 2019) asserted that integrative motivation is a requisite for successful learning. Learners themselves must see the importance of learning the course away from getting extrinsic rewards. Learners must internalize among themselves the value of knowledge and skills acquisition for self-growth, self-fulfilment and self-realization and not for passing and getting good grades in the course alone. Hence, there is a need on the part of the tutor to instil among the learners such mindset.

Results on self-efficacy can serve as an eye opener to tutors of the amount of teaching that has to be done to ensure the mastery of the computational skills. Given that self-efficacy is one of the most contributing factors for learning, it is necessary for tutors to substantiate their instruction by combining learning and psychology. Tutors must acknowledge the fact that learners who have repeated experience success have higher self-efficacy than those students who experience repeated failures in class. Thus, providing a variety of experiences and building positive beliefs in students is essential for students to develop the sense of self-efficacy. On the part of the learners, there is a need for them to have full awareness of their skills related to the course for it will help them determine what are their strengths as well as the aspects they need to enhance to better perform in the subject.

In terms of Engineering Fundamentals' learning anxiety, it can be deduced that though participants have been exposed to engineering courses, there are still aspects of learning the course in which they are anxious such as preparing for class, working on homework and getting good grades. Hence, tutors and instructors should endeavour on strategies and classroom atmosphere, in general, that are more learner-friendly. Engaging to such could be translated to less anxious learners, hence are more comfortable in participating to in class learning activities and assessment.

As what Bandura (1997, p.214) mentioned, "the major goal of formal education should be to equip students with the intellectual tools, efficacy beliefs and intrinsic interests to educate themselves in a variety of pursuits throughout their lifetime."

Further investigation on the learning motivation, self-efficacy and anxiety should be done using variables such as tutors' profiles including their teaching methods and strategies and a wider sampling in another research setting so that comparison of results can be done. Other factors such as learners' reasons for having those levels of motivation, anxiety and self-efficacy toward learning could also be explored in the future studies. Finally, tutors' practices that help contribute for learners to have higher motivation and self-efficacy and lower anxiety in learning could also be identified.

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