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HIGH FAILURE RATE IN MATHEMATICS SUBJECT: INFLUENCING FACTORS AND STUDY STYLES

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ABSTRACT

The objectives of this study are to determine factors that contribute to the Engineering Calculus subject failures and to analyse the study styles of students taking this course. Based on the literature search, these factors are categorised into three domains which are students' attitude, students' background and teacher-related factors. A survey research was done to a sample of engineering degree students who are taking Engineering Calculus subject at their third semester. It was found that non-systematic study style is the greatest factor which has been claimed by the respondents as the main reason for their failures. Besides this, a majority of the students are comfortable with studying alone, as compared to taking part in study group or seeking help from lecturers. These findings suggest that corrective actions should be taken by the students, lecturers, as well as the faculty in order to cope with the alarming failure rate of mathematics subject.

Keywords: *failure rate, engineering calculus, mathematics, study style, students' attitude*

INTRODUCTION

Mathematics is very important in our daily lives as many activities, directly or indirectly, deal with mathematics. A good understanding in mathematics is essential for obtaining good employment. Individuals with high mathematical competency are needed to ensure a continued production of highly-skilled people to fulfil the demand by the industry, science and technology. Having a strong background in mathematics is crucial as it is a basic requirement in variety of university courses at tertiary level study. Among the group of mathematics subject taught in universities, Engineering Calculus is a core subject which is compulsory for all undergraduate engineering degree courses. Despite of being the prerequisite for engineering courses, a preliminary research has found that many students perceived calculus as high level of difficulty among any other mathematics courses. An analysis of Engineering Calculus results over a number of semesters in a local university has shown an alarming rate of failure in the subject. The students' performance in selected engineering courses indicates that the passing rate is low. This is against the entry requirement in engineering degree courses which demands them to have a very strong mathematics skill. From the researchers' point of view, there has been not much research conducted in the university, focusing on mathematics high failure rate. In light of this matter, there is a need for some investigations on the factors which contribute to this problem. The objectives of this study are to determine the reasons for Engineering Calculus subject failures and to analyse the study styles of the students taking this course. This research focuses on a group of selected engineering students in a local university.

RELATED WORKS

The root causes of high student failures in mathematics have been extensively studied in literatures. Naidoo and Naidoo (2007) used a computer laboratory to create a learning environment that promoted interactive learning together with traditional learning. It is observed that among the reasons are lack of understanding in mathematics, large class size, wrong manipulation of approaches in problem solving and insufficient class hours. Tachie and Chireshe (2013) have identified that a shortage of teaching aid materials, incompetency of teachers and lack of students'

efforts in studying mathematics are the reasons that contribute to the high failure rate. To deal with this problem, the basic concept of teaching and learning mathematics must be understood by both students and lecturers. Otherwise, learning mathematics will be full of errors and misconceptions (Makonye, 2013). A study done by Eng, Li and Julaihi (2013) has found that students depend very much on lecture notes as basis for learning. Despite of the students' participation in small groups and classroom which were above average, other instructional systems such as students' participation in laboratory and usage of concrete materials for mathematical exploration were below average.

Allen *et al.* (2013) identified specific features of teacher-student interaction in classroom using a standardised scoring system. The scales are organised into three domains, namely emotional support, classroom organisation and instructional support. It was found that emotional support and instructional support were strongly related to achievement in small classroom. This is because the sensitivity to student needs or high quality feedback to students might have great effect when they are concentrated among fewer students. Sakiz, Pape and Hoy (2012) explored the importance of perceived teacher affective support in relation to sense of belonging, academic enjoyment, academic hopelessness, academic self-efficacy and academic effort in mathematics school classrooms. It was reported that greater sense of belonging in mathematics class has led to higher academic enjoyment. In addition, there is a negative correlation between sense of belonging and academic hopelessness. Other than this, academic enjoyment has direct relations with academic hopelessness and academic self-efficacy due to the presence of perceived teacher affective support and perceived sense of belonging.

Mata, Monteiro and Peixoto (2012) investigated the interrelationship between some selected variables that could influence student attitudes towards mathematics. Among the variables are individual background, motivation and social support. The results show that students had positive attitudes towards mathematics even though their score is around midpoint scale. In addition, medium achievers show gradual decrease in attitudes towards mathematics across the school years. Besides this, teacher support shows closer relationships to attitudes. It represents the third strongest relationship that shows the importance of teachers in the development

of positive attitudes towards mathematics. Mijs (2016) study students' attributions of failure in mathematics subject among secondary school students in 24 countries. A student's inability, poor support from teacher and bad luck are the three factors which emphasis the potential explanation for the students' failure to do well in mathematics.

Factors related to successful completion in mathematics course are explored by Bagley (2015). Factor of gender was found to have little effect on the course. Other factors which have significant effect are the students' prior preparation for the course, high school background, students' anxiety, attitude and mind-set toward mathematics. Nur (2010) studied teacher-related factors and student-related factors that influence student performance in mathematics course. The teacher-related factors focus on the teachers' attitude towards mathematics, the teachers' qualification and the teaching method and material used. On the contrary, the student-related factors are looking at the students' attitudes towards mathematics and their background, in terms of curriculum and motivation.

Table 1 presents the summary of the relevant works that focus on the factors that contribute towards the high failure rate in mathematics courses. By examining the various factors covered by these literatures, Table 1 categorises them according to three large aspects, which are students' attitudes, students' background and teacher-related factors.

Table 1: Cross Analysis on Factors Underlying High Failure Rate in Mathematics

| | | Students' Attitudes | Student Background | Teacher-related Factors |
|----|-----------------------------|---------------------|--------------------|-------------------------|
| 1. | Mijs (2016) | | √ | |
| 2. | Bagley (2015) | √ | √ | |
| 3. | Allen <i>et al.</i> (2013) | | √ | √ |
| 4. | Eng <i>et al.</i> (2013) | | √ | |
| 5. | Taichie and Chireshe (2013) | √ | | √ |
| 6. | Mata <i>et al.</i> (2012) | √ | √ | |
| 7. | Sakiz <i>et al.</i> (2012) | √ | | |
| 8. | Nur (2010) | √ | √ | √ |
| 9. | Dewitt (2000) | √ | | |

METHOD

From the literatures, there are three main factors which contribute to the high failure rate in mathematics courses. Therefore, this survey is aimed to understand the problems encountered by students in learning mathematics course at a selected local university. In this context, this research looks at how these three factors affect the learners in their experience taking the subject. The survey research is conducted on a sample of engineering degree students who are taking Engineering Calculus course at their third semester. These students come from a wide range of social and economic backgrounds. Figure 1 presents the student distribution according to their degree courses.

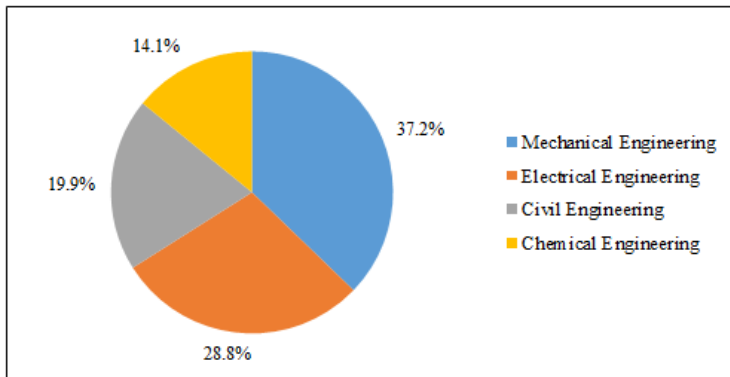


Figure 1: Student Distribution According to Degree Courses

A total of 836 engineering students in 61 classrooms of 25 mathematics lecturers in four engineering degree courses participated in this survey. Data were collected during class hours. Besides the demographic profiles, the questionnaire seeks to collect information on students' perceptions towards mathematic, factors that contribute towards high failure rate and the students' study styles. There are also open-item questions given in the questionnaire to obtain students' suggestions. Questionnaires were administered in the classroom under the supervision of a lecturer. Students then returned the questionnaires to the lecturer, before the questionnaires were handed over for data analysis purposes.

RESULT AND DISCUSSION

In this paper, findings obtained from the questionnaires are presented in two sections. The first section is the analysis on the factors that contributes to the failure of Engineering Calculus subject, namely students' attitude, students' background and lecturer-related factors. The second section is the students' learning style when they study this subject.

Factors contributing to the failure of Engineering Calculus subject

Based on the literature review, factors contributing to students' failure in mathematics courses can be grouped into three large aspects, namely students' attitudes, students' background and teacher-related factors. As these aspects are crucial and seriously affect the students' performance in the colleges or universities, this research attempts to focus on these aspects in the survey. The results presented in Table 2 focus on the three main factors contributing to students' failure in the Engineering Calculus subject.

A total of 836 engineering students responded to the survey. They were asked to share their perception on the Engineering Calculus subject. From the entire respondents taking part in this study, 17.9% of them are repeating students who have at least failed once in the subject. They are asked to choose the factors that contribute to their failure in the past. These factors are shown in Table 2. The learners are allowed to choose more than one factor, whichever they believe had significantly contributed to their failure.

Table 2: Learners' Reasons for Engineering Calculus Subject Failures

| Students' Attitude: | |
|---------------------------------|-------|
| Study Style | 79.3% |
| Class Absenteeism | 12.0% |
| Students' Background: | |
| Course is difficult | 51.3% |
| Unable to understand problem | 38.0% |
| Personal Problems | 6.2% |
| Lecturer-related Factor: | |
| Change Lecturer | 22.0% |

Students' Attitude

A large percentage of 79.3% of the learners in the survey attributed their failure to the non-systematic study style. They admitted that they do not have a systematic way of study, such as having daily or weekly group discussions, consistently working out the tutorial questions or seeking help whenever in doubt. Many of these students devote their time studying mathematics when the examination is around the corner. This last-minute preparation only leads them to experience fear, anxiety and nervous as they are afraid that they could not score in the examination. Furthermore, the absorption of the mathematical concepts and formulae is less effective at this stage.

There is a percentage of 12% of the students who admitted that class absenteeism also contributes to the high failure rate. As the syllabus is heavy, a large amount of lesson is covered in each single day lecture. When students are absent from a class, they are not able to catch up in the subsequent class because of the missed lecture earlier. As a result, they become frustrated, feeling left behind and disappointed with the course.

Students' Background

51.3% of these repeaters believed that mathematics is difficult by nature. Some of them claim that there is very little they can do to pass the subject due to their weak basic foundation of mathematics. Having a weak mathematical basis, they are not able to identify suitable method to solve a particular problem, which normally has more than one solution method. They are easily confused with the various solution techniques and these reasons have made them claim that the course is difficult. Normally, they get confuse because of the way the formula is written. Mathematics formula can be written in different ways, yet carries the same meaning. In many cases, wrong values are substituted into the formula and hence, wrong answer is obtained.

Besides this, there is also relatively a large percentage of 38% of the respondents who find that they face difficulties to understand the given problem. They are unable to understand the concept of the mathematics question in the context of the realistic real world problem and fail to identify the correct skills to answer the given question. These difficulties largely refer to the subtopic of double and triple integral, in which solution steps always

involve lengthy procedures. These students face difficulties in visualising 3-dimensional functions. These questions involve 3-dimensional functions such as sphere, paraboloid, cone and cylinder. Such questions usually require them to visualise, draw and finally solve the given problem. In understanding the given problem, language barrier is not found to be a significant problem for the students who took part in the survey. Students are familiar with mathematics vocabulary as many local schools are teaching mathematics in English. This may have equipped them with the ability to understand mathematics concept in English, communicate using mathematical terms in English and translate them into their problem solving workings.

There is a small number of respondents who attributed their failures to personal problems. The personal problems sighted include health, family, financial and social problems accounting for 6.2% of the entire number of repeaters. When students are unable to cope with their personal problems, they tend to lose focus in class and their motivation level declines. Some of their personal problems are discussed with the academic advisors of the faculty in which some cases are successfully solved. However, some students choose to keep the problem to themselves and no efforts are done to solve it. This leads to a deterioration of the students' performance in class and contributes to the high failure rate in the subject.

Lecturer-related Factors

A change in the Mathematics lecturer during the middle of the semester is another factor which contributes to the failure rate among repeating students. The change of lecturer is due to lecturers' teaching load, where some classes are assigned two lecturers in which each of them would teach the class for half semester. 22% of the students surveyed are not happy with this method of class arrangement. They find difficulties in adapting to the different teaching style of each lecturer. Generally, there are no other lecturer-related factors recorded from the survey and the students are happy with the lecturers and their teaching style.

Students' Learning Style

From the survey done on the repeating students who have failed the subject at least once, 79.3% of them claimed that they are practicing a non-systematic study style. This factor forms the largest proportion among other reasons given for the failure. Therefore, the other objective of this research

is to analyse the study style of the students in the survey. The learners are allowed to choose more than one learning style, whichever they practiced in learning the Engineering Calculus course. The result obtained is presented in Figure 2.

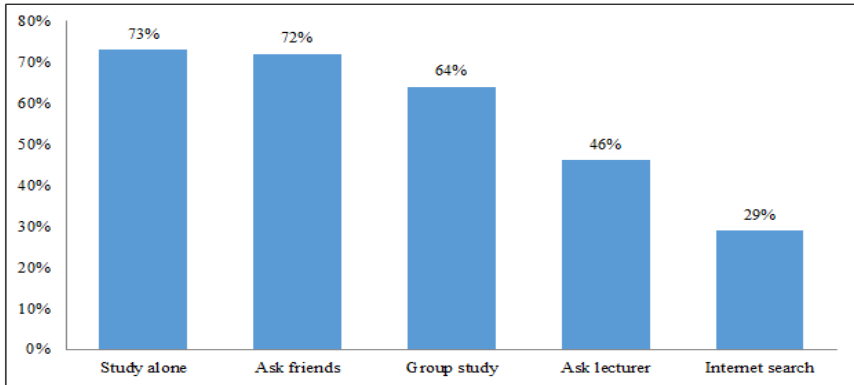


Figure 2: Students' Learning Style

The survey results indicate that there are some obvious variations in the students' learning style among the Engineering Calculus learners. Among the learning styles that are widely practiced are studying alone, seek friends help, group study, consult lecturer and internet search.

Every student has their own style of studying. Majority of the students choose to study alone. They believe that they find comfort and peace and are able to retain more information in a quiet setting. Besides studying alone, a large number of students also prefer to seek help from friends whenever in doubt. Friends are the closest people they look for, when they need clarification on any uncertainties on the subject matter. As long as the friends are able to discuss and explain the subject matter, then asking friends could be a good learning style. In the case if the friends are unable to answer their queries, then this will lead to frustration and disappointment which will demotivate them.

A proportion of 64% of the respondents practice study group for the subject. The study group is used as a platform for them to share information, change ideas, attempt the problem solving with others and identify any working errors. Group study also helps to reinforce ideas and improve knowledge retention and enhance thinking skills.

46% of the students choose to seek help from the lecturer when they face problems. In general, many students refused to approach the lecturer as they are shy, afraid of asking questions or claim that lecturers are too busy to attend to them. Apart from this learning style, a small percentage of 29% of the students use internet search to look for further clarification regarding the subject matter.

One learning style is not necessarily better than the other. One style might be better for a certain group of students but not for the other groups of students. It is all depends on the individual, as to which study style is suitable and effective for him or her. What is important is finding an effective study method where they are able to concentrate, stay focused and grasp the subject matter better.

CONCLUSION

This study investigates reasons that led to the high failure rate in Engineering Calculus subject. In this paper, three domains are looked into namely students' attitude, students' background and lecturer-related factors. A survey research was done on a sample of engineering degree students who are taking Engineering Calculus subject at their third semester. It was found that non-systematic study style is the greatest contributing factor for their subject failures. This aspect lies in the category of students' attitude. Another significant reason is due to the nature of the calculus mathematics course itself, which students claimed to be difficult. Upon investigating the students' study style, it is discovered that a majority of the students choose to study alone, rather than taking part in group study or seeking help from lecturers. The present study only examined the reasons for the high failure rate for the course. Further research could be focused on the corrective actions that should be taken by the students, lecturers, as well as the faculty in order to tackle the problem of high failure rate.

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