# Factors Related to Students' Performance in Calculus 

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#### Abstract

A research was carried out on 608 diploma students who are taking Calculus, which consists of Pre-Calculus, Calculus I, Calculus II and Calculus III. The failure rates for Calculus I and Calculus II are above $30 \%$ for nearly every semester. This research is done to investigate the factors related to the students' performance in Calculus. The respondents are the students in semester 2, 3, 4, 5 and 6 of Diploma in Mathematical Science and Diploma in Computer Science, Universiti Teknologi MARA (UiTM) Johor branch, Segamat. In this paper, the sample size is 180 students selected randomly for each code of Calculus from semester 2 2014/2015 only. Online questionnaires were distributed to the students, and ANOVA descriptive analysis was used to analyze the factors related to the respondents' performance in Calculus. The result found that self-effort is the only related factor to the students' performance in Calculus in this research.


KEYWORDS: Calculus, Performance, ANOVA, Questionnaire.

## INTRODUCTION

Behavior is defined as a person's action that can be seen or heard. Therefore, the behavior may give significant impact, in particular to the students' action in their study. In [1] defined behavior as an action that is observable and measurable, so that everyone has a good understanding of what the behavior looks and sounds like. Besides students' behavior, students' preference also may be related to their performance of study.

The failure rates for Pre-Calculus and Calculus 1 are very serious problems because nearly every semester, more than $30 \%$ of Diploma in Quantitative Science (CS113), Diploma in Computer Science (CS110) and Diploma in Mathematical Science (CS143) students failed Calculus. In this paper, the passing and failure rates for the most recent six semesters are presented for CS110 and CS143 for Pre-Calculus, Calculus I and Calculus II are shown in Table 1, Table 2 and Table 3 respectively and Table 4 shows result of final exam for Calculus III, taken by CS113 and CS143. However, the respondents in this research are from CS110 and CS143 from semester 2 2014/2015 only.

Table 1: The passing and failure rates for Pre-Calculus

| Pre Calculus | CS110 |  | CS143 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Stds | Pass | Fail | Stds | Pass | Fail |
| 2012/ 13 Sem 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012/ 13 Sem 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013/14 Sem 1 | 0 | 0 | 0 | 187 | 98.4 | 1.6 |
| 2013/14 Sem 2 | 13 | 92.3 | 7.69 | 31 | 96.8 | 3.2 |
| 2014/ 15 Sem 1 | 286 | 59.4 | 40.6 | 128 | 94.5 | 5.5 |
| 2014/ 15 Sem 2 | 125 | 86.4 | 13.6 | 21 | 95.2 | 4.8 |

Table 1 shows that in semester 2 of 2013/2014 session, the failure rate is $4.45 \%$ ( $2 / 44$ students failed). However, the failure rate tremendously increased to $29.7 \%$ when 123 from 414 students failed and then reduced again to $12.3 \%$ ( $18 / 146$ students failed). The trend shows that the failure rates for Calculus 1 and Calculus II for CS110 students are more than $30 \%$ but not for CS143 students, as indicated in Table 2 and Table 3 respectively.

Table 2: The passing and failure rates for Calculus I

| Calculus I | CS110 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Stds | Pass | Fail | Stds | Pass | Fail |
| 2012/ 13 Sem 1 | 69 | 82.6 | 17.4 | 0 | 0 | 0 |
| 2012/13 Sem 2 | 96 | 35.4 | 64.6 | 0 | 0 | 0 |
| 2013/14 Sem 1 | 55 | 54.6 | 45.5 | 0 | 0 | 0 |
| 2013/14 Sem 2 | 237 | 61.2 | 38.8 | 180 | 97.8 | 2.2 |
| 2014/15 Sem 1 | 113 | 54 | 46.0 | 33 | 93.9 | 6.1 |
| 2014/15 Sem 2 | 214 | 80.8 | 19.2 | 121 | 95.0 | 4.96 |

Table 3: The passing and failure rates for Calculus II

| Calculus II | CS110 |  |  | CS143 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Stds | Pass | Fail | Stds | Pass | Fail |
| 2012/13 Sem 1 | 100 | 78 | 22 | 0 | 0 | 0 |
| 2012/13 Sem 2 | 61 | 83.6 | 16.4 | 0 | 0 | 0 |
| 2013/14 Sem 1 | 46 | 69.6 | 30.4 | 0 | 0 | 0 |
| 2013/14 Sem 2 | 45 | 35.7 | 64.4 | 0 | 0 | 0 |
| 2014/15 Sem 1 | 170 | 62.9 | 37.1 | 173 | 92.5 | 7.5 |
| 2014/15 Sem 2 | 105 | 68.6 | 31.4 | 43 | 88.4 | 11.6 |

Table 4: The passing and failure rates for Calculus III

| Calculus III |  | CS110 | Fail | Stds | Pass | Fail |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Stds | Pass | Fail |  |  |  |
| 2012/ 13 Sem 1 | 20 | 100 | 0 | 0 | 0 | 0 |
| 2012/13 Sem 2 | 84 | 86.9 | 13.1 | 0 | 0 | 0 |
| 2013/14 Sem 1 | 38 | 89.5 | 10.5 | 0 | 0 | 0 |
| 2013/14 Sem 2 | 61 | 91.8 | 8.2 | 0 | 0 | 0 |
| 2014/15 Sem 1 | 12 | 91.7 | 8.33 | 0 | 0 | 0 |
| 2014/15 Sem 2 | 10 | 100 | 0 | 160 | 98.1 | 1.87 |

Table 4 shows a satisfactory passing rate for Calculus III, which is more than $80 \%$ since only CS113 and CS143 students took this subject.

Based on the results shown in Table 2 and Table 3, a research was done to investigate the factors related to the students' performance in Calculus, which have a wide dimension. In this research, the factors are divided into two parts: (1) students' behavior which consists of self-effort and personal attitude and (2) students’ preference which consists of lecturers' attitude and size of class.

## LITERATURE REVIEW

The Free Dictionary by Farlex has defined effort as the act of trying to do something or the use of physical or mental energy. In [8] reported that there was a positive correlation between attitude, self-efficacy, effort and students' academic achievement as measured by Pearson's correlation coefficient. The results showed that both attitude and self-efficacy could significantly predict effort by a multiple regression analysis. Similar results by [12] such that a student's effort will be greater if his or her self confidence is high. Therefore, students' effort will significantly influence overall student's performance $[2,14]$.

According to $[4,6,13,15,17]$, attitude plays an important role in a student's excellence. Students with low motivation can be seen by looking into their attitude towards mathematics classes such as skipping class, coming in late and not finishing their homework [9]. Laziness and reluctance to ask questions in class because of shyness are also a part of attitude that students may reveal when dropping out of the subject [16].

Teachers' attitude is the external factor, which affects the students' performance in Mathematics. Analysis had been done through data that was gathered using questionnaires and the students' end of term examination scores. There is a significant relationship between teachers' attitude and students' attitude toward Mathematics subject [10]. Thus, if more teachers give full support to their students, there will be more students with positive attitude towards mathematics [9].

Previous research also has found that class size can also affect students' performance. Class size can be defined as the total number of students that a teacher has under his or her supervision. The class size gives little effect on students' performance in class [7], but in [3] found out that the performance of students is better if the class size is lower. This statement is contrary to [11], which had carried out a research on the possible effects of class size on students' academic performance in a Principle of Microeconomics class. The regression results did not show any negative and significant effect of class size on a student's academic performance. On the other hand, the class size affected the teachers' efficiency more. In [5] also stated that class size has no effect towards students' achievement in calculus.

In this research, a set of questions has been addressed to see if there is any difference of mean value of factors that is related to the performance of students.

## METHODOLOGY

This section is to elaborate instruments, respondents, data set and statistical tools for the research. This research is done to investigate the factors related to the students' performance in Calculus. The considered factors in this paper are in two parts: (1) students' behavior and (2) students' preference. The research framework is shown in Figure 1.


Figure 1: Research framework
Two hypotheses for each part were developed:

## Students' Behavior

$\mathrm{H}_{0}$ : no difference in mean values of final score between groups of self-effort, personal attitude.
$\mathrm{H}_{1}$ : at least one of the mean values is different between groups of self-effort, personal attitude.

## Students' Preference

$\mathrm{H}_{0}$ : no difference in mean values of final score between groups of lecturers' attitude, class size.
$\mathrm{H}_{1}$ : at least one of the mean values is different between groups of lecturers' attitude, class size.

## Instruments and Respondents

Based on the factors highlighted in the literature review, a research was carried out based on 608 diploma students who are taking Calculus. Online questionnaires were distributed to the students during lab class and an average of 5-10 minutes was used to answer all the questions.

The respondents are students in semester 2, 3, 4, 5 and 6 of Diploma in Mathematical Science (CS143) and Diploma in Computer Science (CS110), Universiti Teknologi MARA, Segamat, Johor who are taking Calculus which consists of Pre-Calculus, Calculus I, Calculus II and Calculus III from semester 2 2014/2015.

## Statistical Tools and Data Set

ANOVA was used to analyze the related factors to the respondents' performance in Calculus from semester 2 2014/2015. The size of sample is 180 selected randomly, which consists of 48 students from Pre-Calculus and Calculus I, 49 students from Calculus II and 35 students from Calculus III as shown in Table 5.

Table 5: Population table of diploma students taking Calculus

| Course Codes | Total of Students (Sample) |
| :---: | :---: |
| Pre-Calculus | $48 / 110$ |
| Calculus I | $48 / 265$ |
| Calculus II | $49 / 120$ |
| Calculus III | $35 / 113$ |
| Sampel size | $180 / 608$ |

Findings of the research are discussed in the next section.

## RESULTS AND DISCUSSION

In this section, output for each factor is presented. Analysis is made by using ANOVA via SPSS version 21. The independent variables are self-effort, personal attitude, lecturers' attitude and size of class while dependent variable is the students' performance in Calculus based on the results of final exam semester 2014/2015.

## Students' Behaviour

Two factors are considered under students' behavior which are self-effort and personal attitude. The instrument to test self-effort of students in learning Calculus is how frequent they put their effort in studying Calculus. Two intruments for personal attitude to investigate their action on finding the way to solve problems in Calculus and to make effective Calculus class. The instruments are as follows.

## Self-Effort

I often study Calculus
1 -every day
2-every weekend
3-immediately before quizzes/tests/exam

## Personal attitude

a) If I encounter problems while studying Calculus, the most preferred action in finding the solutions is

1-to find my own reference
2-to discuss with friends only
3-to discuss with the lecturers only
4-to leave the questions without answers.
b) To make the class more effective, I prefer for all questions given in class,

1-lecturer should show all the solutions so that it will be easy for me to study Calculus faster.
2-lecturer should show half of the solutions so that it will be easy for me to continue later on.
3-I should try the questions first so that I can test my understanding of Calculus.
The results are summarized in Table 6 for the groups of self-effort and personal attitude. P-value for selfeffort is less than $\alpha(0.05)$, therefore, the null hypothesis is rejected. There is at least one group of self-effort has different mean value in terms of studying Calculus whether every day, every weekend or last minute before quizzes, test and exam.

Table 6: ANOVA of students' behaviour

| Factors | F-Test | P-Value |
| :---: | :---: | :---: |
| Self-effort | 15.243 | 0.000 |
| Personal attitude |  |  |
| a) | 0.072 | 0.930 |
| b) | 0.355 | 0.702 |

Thus, self-effort among the students is different with regards to the students' academic performance. The finding is agree with [2, 14]. However, for personal attitude, the test is not significant at the $5 \%$ significance level. Thus there is no difference in mean values between the groups of personal attitude.

## Students' Preference

Preference also considered two factors which are lecturers' attitude and class size. The instruments for these factors are as follows.

## Lecturers' attitude

The lecturer that I like most for teaching Calculus is
1 -fierce
2-kind
3-tolerent
4-serious
5-joker
6-firm/strict

## Class size

I feel more comfortable learning Calculus in class with
1-15-20 students
2-21-25 students
3-more than 25 students
The results are summarized in Table 7.
Table 7: ANOVA of students' preference

| Factors | F-Test | P-Value |
| :---: | :---: | :---: |
| Lecturers' attitude | 0.197 | 0.821 |
| Class size | 1.746 | 0.178 |

Both factors shown in Table 7 are not significant since the p -values are greater than $\alpha(0.05)$. The results shows that there is no difference for the preference of the studentd on their lecturers' attitude and class size to their performance in Calculus. This result clearly contradicted the previous research for lecturers' attitude or teachers' attitude which has positive relationship with the students' academic performance [9-10]. However, it agreed with $[5,11]$ such that there is no significant effect of class size on students' academic performance.

This research is conducted to survey the factors related to the students' performance in Calculus for CS110 and CS143 students of UiTM Johor branch, Segamat campus.

In this research, the dependent variables are students' academic performance in the final exam for semester 2 2014/2015. The main objects of this research are the factors related to the students' academic performance in Calculus. The factors were divided into two perspectives: (1) students' behavior and (2) students' preference.

By using the ANOVA test, it is found that all the tested factors are not related to the students' performance in Calculus except self-effort. In this research we have found that there exists a difference in mean values of final score for students' behavior. However, the factors under students' preference showed no difference in mean values of final score.

## CONCLUSION

This research is vitally important especially to the lecturers and students themselves. In this research, students' behavior and students' preference were considered as the main factors that may be related to students' performance in Calculus. The result shows that the only factor that is related to the students' performance in Calculus is students' behavior (self-effort). On the other hand, students' preference in terms of lecturers' attitude and class size are the same regardless of their scores in Calculus.

In conclusion, self-effort is the factor that is related to the students' performance in Calculus. The other factors did not show significant difference of mean value of performance in Calculus.

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