

## Academic Performance and Happiness Differences in Attitudes Toward Calculus

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**Abstract:** Both attitude and happiness of learners are generally accepted as contributing factors towards the achievement in Mathematics. However, studies explicating the relationship between the two towards a specific course and the corresponding achievement of the student are lacking. This study intends to fill this gap by studying the attitude of the students towards calculus and to determine the differences in attitudes scores in respect of gender between achievement below 50% and at least 50% and with among three categories of happiness level. The results obtained reveal that the “value” scale is perceived as the most important follows by enjoyment, motivation and self-confidence by the students. Interestingly, female students observed better in terms of value, enjoyment and motivation scales. It is also noticed that students who scored at least 50% in their calculus are apparently those with a better attitude. Furthermore, all level of happiness are found statistically significant across the four scales of attitudes, showing that happy students have a relatively higher value, enjoy more, greater motivation and more confidence towards calculus. Consequently, this study suggests that attitude and happiness of learners are two imperative intertwining factors that play a significant role for learners to perform in Mathematics generally and calculus specifically.

**Key words:** Academic performance, happiness, attitude, calculus, gender, Mathematics

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### INTRODUCTION

Improving the performance of the students in Mathematics has always been one of the core businesses of the Ministry of Education across nations. The reports from globally recognized and well-established assessment programme like Trend in International Mathematics and Sciences Studies (TIMSS) and Programme for International Student Assessment (PISA) have been used by the participating countries including Malaysia as a benchmark to evaluate the achievement of their students in Mathematics (MEM., 2013). Actions, initiatives and approaches are planned and implemented with the intention to ensure that our students are mathematically equipped in this Science, Technology, Engineering (Arts) and Mathematics (STEM or STEAM) era.

At the same time, Mathematics being a whole subject in the primary and secondary education level, the field of Mathematics is actually broad. Different Mathematics courses are offered in the tertiary education level in corresponding to the program or faculty a student enrolled to. Calculus is usually offered by typical

engineering, sciences, technology and business related programs. Therefore, making sure students perform in calculus is imperative to the success of their study.

The achievement of students in Mathematics is the result of the systemic interaction of many influencing factors attributing from multiple parties. They include but not limited to, the students themselves the family they belong to the society and community they are in the school they study at and the teacher they relate to in their Mathematics classes (Can *et al.*, 2017).

For the students or learners, the attitude and state of emotion during the teaching and learning sessions are two pertinent factors in influencing the learning outcome which is their Mathematics achievement (Can *et al.*, 2017). Students who are happy and possess better attitude are generally observed to perform better in their Mathematics and happy students tend to have a better attitude towards Mathematics and vice versa (Papanastasiou, 2000; Hodges and Kim, 2013; Adamu *et al.*, 2015; Huang and Lin, 2015; Tabbodi *et al.*, 2015; Ajisuksmo and Saputri, 2017; Can *et al.*, 2017).

A standard definition of attitude in learning could hardly be found. It is generally defined as a factor that is consisting of three to four scales. Can *et al.* (2017) stipulated that the attitude of a learner in learning Mathematics is considered of comprising three main elements which include the emotion or feeling (affective) one has when deals with Mathematics, the vision or beliefs (cognitive) one has towards the value of Mathematics or advantages of learning Mathematics and the reaction (behaviour) one take towards the Mathematics learning.

On the other hand, some researchers regard attitude as an expression of whether an individual enjoys Mathematics, shows passion or inclined to Mathematics activities, considers one to be successful in dealing with Mathematics and believes Mathematics is useful (Huang and Lin, 2015). These four scales are then captured in tools designed to measure the attitudes of the students toward Mathematics which is referred to as Attitudes Toward Mathematics Inventory (ATMI) (Lim and Chapman, 2013). ATMI is then further customized, specifically, for calculus offered in tertiary education institutes and it is termed as Attitudes Toward Calculus Inventory (ATCI) (Huang and Lin, 2015). The four scales included in both ATMI and ATCI are self-confidence, value, enjoyment and motivation.

In ATCI, items developed for self-confidence intend to measure whether students believe that they are capable to succeed in calculus, for motivation, to measure the interest of students in calculus and their desire to pursue calculus, for value, to measure the beliefs of students in the aspects of usefulness, relevance and worth of calculus in their lives and for enjoyment, to measure how much students enjoy the calculus problems and calculus lectures (Huang and Ling, 2015).

In many studies that look into the relationship between the emotion and the performance in academic or workplace, the factor of happiness or well-being always stand out (Can *et al.*, 2017; Barros-Justo *et al.*, 2018). The state of happiness of an individual while performing a task is reported as associated with the level of self-confidence, the degree of satisfaction in life, the depth of positive belief in the future and life (Hodaeova *et al.*, 2011; Can *et al.*, 2017) which are the scales of attitude. The learners who are happy are found to be a better problem solver, perform better and achieve more in any tasks they are engaged by Can *et al.* (2017). Conversely, some studies showed that students who tend to withdraw from learning Mathematics are those who are not happy (Smith, 2010). As stipulated by Noddings (2003), "happiness and education are properly,

intimately related: happiness should be an aim of education and a good education should contribute significantly to personal and collective happiness".

Among numerous tools developed to measure the level of happiness of an individual, the Oxford Happiness Questionnaire (OHQ) (Hills and Argyle, 2002) is a widely used tested and well-established tool usable across fields of studies. Hence, OHQ is a practical tool to be adapted to measure the level of happiness of the students enrolled in Mathematics generally and calculus specifically. The score is interpreted as not happy for a score of 1-2, somewhat unhappy for 2-3, not particularly happy or unhappy for 3-4, somewhat happy or moderately happy for 4, rather happy for 4-5, very happy for 5-6 and too happy for a score of 6 the highest score (Wright, 2008).

With regards to the aspect of gender, studies showed that female has higher emotional intelligent whereas the male has a higher level of self-esteem and life-satisfaction (Pantrakool and Chanchalor, 2018). Male students are reported to have a more positive attitude towards Mathematics but both genders are found equally confident in handling Mathematics (Ajisuksmo and Saputri, 2017). On the other hand, there are studies found that female is happier and has a better attitude towards calculus than their counterpart and they are reported to score higher than the male for their calculus. Conversely, other studies revealed that there exists no significant difference between male and female students on their attitude towards Mathematics while reporting that the later perform better, though slightly, in Mathematics (Adamu *et al.*, 2015).

Interestingly, the typical definition of attitude as presented earlier are noticed to be closely related to the state of well-being or happiness of an individual. Happiness is commented as closely associated with self-confidence, ability to see the value in life, motivation and enjoyment (Hodaeova *et al.*, 2011; Nakamura, 2018; Dong and Xue, 2019). Can *et al.* (2017) commented that the level of happiness of students appears to be positively associated with the attitudes towards Mathematics.

Nevertheless, studies investigating the intertwining relationship between the attitude, its scales and happiness of the students and their academic achievement particularly in Mathematics generally and calculus specifically are very lacking and could hardly be found (Can *et al.*, 2017). Consequently, we intend to fill this gap by studying the attitude of the students towards calculus and to determine the differences in attitudes scores in respect of gender between achievement below 50% and at least 50% and with among three categories of happiness level.

**MATERIALS AND METHODS**

We collected the data through the use of online survey form by spreading the link of the form to all students who are registered for the first level of calculus for the semester of March 2018. The students involved are from three faculties which are Faculty of Engineering, Faculty of Computer and Mathematical Sciences and Faculty of Applied Science of a local public university. Out of 257 students, 190 students participated in our study with 119 female and 71 male students with a response rate of 74%.

The survey form used in this study consists of three sections: section A-C. Section A is intended to obtain the demographic background of the students. Section B comprises of happiness questionnaire which is adapted from the 29-item OHQ to capture the perception of the students with regards to the perceived happiness towards calculus. Each item was rated on a 6-point scale (1-strongly disagree, 2-moderately disagree, 3-slightly disagree, 4-slightly agree, 5-moderately agree, 6-strongly agree). The last section, section C adopted the 24-item ATCI. For this section, the item was rated on a 5-point Likert scale (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree).

We analysed the data by using the Statistical Package for Social Sciences (SPSS) Software. The total score of each scale for each student was calculated to indicate their attitude toward calculus. A one-way Analysis of Variance (ANOVA) and Multivariate Analysis of Variance (MANOVA) was used to compare the means for each scale while Cronbach’s alpha, Mean (M), Standard Deviation (SD) and mean/item were computed for each scale.

**RESULTS AND DISCUSSION**

**Attitudes toward calculus:** Table 1 shows the results of students who answered the survey with the means and standard deviations. The overall mean per item was 3.429. The total attitudes were classified into four levels as negative, moderately positive, positive and highly positive according to quartile percentage. The findings showed that 0.5% and 50% of students had negative and moderately positive attitudes, respectively while the remainder had positive (24.2%) and highly positive (25.3%) attitudes toward calculus.

This result discloses a slightly high percentage of students considered with negative and moderately positive attitudes toward calculus. It implies that most of the students barely find calculus is useful and interesting subject to learn. They also have less confident to relate

Table 1: Items for attitudes toward calculus

Subscale	Cronbach's			Mean/Items
	alpha	Mean	SD	
Self-confidence	0.750	18.03	4.05	3.004
Value	0.925	22.84	4.85	3.807
Enjoyment	0.939	21.29	5.36	3.548
Motivation	0.946	20.15	5.53	3.358

and apply calculus into their daily lives. They may feel confused to construct calculus and feel perplexed in the areas that they would be involved with in the future. Two scales in Table 1 were above the overall mean (3.429). The “value” scale had the highest mean (3.807) while the second highest mean (3.548) for the “enjoyment” scale suggests that students agreed that calculus is very useful and relevant in daily life and careers and they are very enjoy working with calculus and calculus classes very much. The lowest mean of 3.004 reveals that students are lack of confident and anxious in learning calculus. Self-efficacy affects academic achievement and motivation but slightly high motivation and lowest self-efficacy is another stimulating and inconsistent phenomenon. Attitudes toward calculus showed student’s perceptions of the usefulness of Mathematics (Wang *et al.*, 2019). The significance a student attributes to his/her learning calculus is associated to his/her perception of its usefulness. The value of use of calculus for educational and career goals is one factor making involvement in Mathematics. Student has great interest and successful at calculus would have a better understanding of the importance of calculus in a wide range of careers.

**Gender difference in attitudes toward calculus:** Table 2 shows female scored higher than male on “value”, “enjoyment” and “motivation” scale. Female seemed to react positive attitudes toward calculus compared with the male based on the mean score of each scale. An independent samples t-test was carried out to find out, if a significant difference in male and female attitudes toward calculus. An insignificant difference was showed in the total of mean scores for female (M = 89.94, SD = 17.02) and male (M = 81.24, SD = 18.12;  $t(188) = 0.651, p = 0.516$ ) and differences of the means were small ( $\eta^2 = 0.352$ ). A MANOVA test was conducted to analyses the differences between male and female students in that four scales. The mean score of ‘self-confidence’ scale was significant in Table 2. This suggests that male have more confident in their knowledge of calculus, compared with female. However, there was no significant difference among other three scales when measured in terms of their belief in usefulness of calculus, enjoyment and motivation toward calculus.

**Table 2: Differences between males and females**

Scale	Female		Male		F-values	Sig.	Partial ( $\eta^2$ )
	Mean	SD	Mean	SD			
Self-confidence	17.35	3.67	19.15	4.410	9.201	0.003*	0.047
Value	23.33	4.69	22.03	5.040	3.225	0.074	0.017
Enjoyment	21.74	5.25	20.54	5.510	2.256	0.135	0.012
Motivation	20.52	5.59	19.52	5.390	1.460	0.228	0.008

**Table 3: Differences between calculus achievement**

Scale	Below 50%		Equal and above 50%		F-values	Sig.	Partial ( $\eta^2$ )
	Mean	SD	Mean	SD			
Self-confidence	16.84	3.00	18.38	4.26	5.018	0.026*	0.026
Value	20.75	4.68	23.47	4.74	11.211	0.001*	0.056
Enjoyment	18.93	4.51	22.00	5.41	11.685	0.001*	0.059
Motivation	17.84	4.33	20.84	5.67	10.478	0.001*	0.053

**Table 4: Differences between happiness**

Scale	Not happy		Neutral		Happy		F-values	Sig.	Partial ( $\eta^2$ )
	Mean	SD	Mean	SD	Mean	SD			
Self-confidence	13.00	4.32	17.71	3.76	21.74	3.22	18.433	0.000*	0.165
Value	13.57	5.41	22.62	4.39	27.22	2.76	28.843	0.000*	0.236
Enjoyment	11.71	4.31	20.74	4.66	28.04	2.51	43.971	0.000*	0.320
Motivation	10.57	4.12	19.64	4.69	26.61	4.89	37.247	0.000*	0.285

\*Alpha level of 0.05

In general, female have more positive attitudes toward calculus in comparison mean scores for each scale which is supported by Jong *et al.* However, this results seemingly contradict the findings that male has more favourable attitudes toward Mathematics (Gugliotta, 2010). Even though t-test analysis showed that insignificant difference between female and male in terms of their combined attitudes toward calculus, results for the separated scales analysis reveals that male and female students differ significantly in terms of how confident they perceived in learning calculus. Findings also show gender differences did not change their belief in usefulness of calculus, enjoyment and motivation toward calculus. This result disagrees with some researchers reported that there are gender differences in student attitudes toward Mathematics and male students showed more positive attitudes toward Mathematics, compared with female (Ajisuksmo and Saputri, 2017).

**Calculus achievement difference in attitudes toward calculus:** A total of 190 student’s final examination (100%) was used as calculus achievement. Calculus achievement was classified as student’s final examination that is below 50% and student’s final examination that is equal and above 50%. A significant differences in all scale was displayed between student’s final examination that is equal and above 50% (n = 44) and student’s final examination is equal and above 50% (n = 146) on the combined scale with  $F(4,185) = 96.825$ ,  $p < 0.000$ , Pillai’s trace = 0.066,  $\eta^2 = 0.063$ .

Table 3 shows all significant difference in mean scores for each scale. However, mean scores for group of student’s final examination that is equal and above 50%

is higher than group of student’s final examination that is below 50%. This suggests that students who obtained final examination equal and above 50% had more positive attitude toward calculus. Some researchers show a positive significant correlation between student’s self-efficacy beliefs and their academic performance (Can *et al.*, 2017). Results of this study are consistent with finding from Santhanam *et al.* (2019) that students believe they are incapable of achieving or have a low confidence level in Mathematics will cause high failure, bad attitudes toward Mathematics and a low interest in Mathematics courses.

**Happiness difference in attitudes toward calculus:** A total score of happiness for each scale was used and categorized, according to happiness levels which were not happy (student’s score falls in 1-3), neutral (student’s score falls in 3-5) and happy (student’s score falls in 5-6). Table 4 shows happy category scored the highest on all scales among the categories. For each happiness level, it indicates that results which show low motivation is central to unhappiness, high value plays an important attribute to neutrality in happiness and high enjoyment acts as a pertinent influence of happiness for learner.

Furthermore, all categories were statistically significant with attitudes toward calculus on the combined scales;  $F(4,185) = 45.225$ ,  $p < 0.000$ ; Pillai’s trace = 0.361, partial  $\eta^2 = 0.18$ . This proposes that student’s attitudes towards calculus affect changing of student’s happiness level. Happy students would success in learning calculus usually results in raised self-efficacy beliefs, high appreciation on value of calculus, full of enjoyment and interest and strong

motivation in calculus. This finding supports the ideas of Hodaeova *et al.* (2011), Barros-Justo *et al.* (2018) and Can *et al.* (2017).

### CONCLUSION

We wish to inform about the limitations of this study of which the interpretation of the result of this study should be based. They include the small sample size of this study; the perception of the students captured is subjected to the assumption and limitation of the inventories used and the background of the students of this study.

Nevertheless, this study has enlightened community of the field with insights about the academic performance and happiness differences in attitudes toward calculus. We have studied the attitude of the students towards calculus and determined the differences in attitudes scores in respect of gender between achievement below 50% and at least 50% and with among three categories of happiness level. The results obtained reveal the students perceive the "value" scale as the most important among the four and the female students have higher perception towards enjoyment, motivation and self-confidence than their counterparts. We have also noticed that students who failed to pass the final examination are apparently those with lower attitude. All levels of happiness are found statistically significant across the four scales of attitudes, showing that happy students have a relatively higher value, enjoy more, greater motivation and more confidence towards calculus. Consequently, this study suggests that attitude and happiness of learners are two imperative intertwining factors that play a significant role for learners to perform in Mathematics generally and calculus specifically.

### ACKNOWLEDGEMENT

We would like to express our deepest gratitude to UiTM Sarawak for the resources and facilities provided and the researchers of ATCI and OHQ for the permission to use their inventory in this study. We also want to express special thanks to the students who had voluntarily answered the questionnaire. We wish to acknowledge Mr. Mohd Yazid Mohd Anas Khan and Ms. Fatimatul Anis Bakri for their kind help.

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