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Undergraduate mathematics achievement: exploring the students' attitude, self-efficacy and anxiety

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ABSTRACT

Underachievement in mathematics has been a great concern globally for decades and remains hotly debated in many research studies. Various factors related to students' mathematics achievement have been widely discussed. This study examines the undergraduate students' mathematics achievement (Pre-Calculus result) across gender and mathematics background (SPM Mathematics & SPM Additional Mathematics results). This study also investigates the students' attitude, self-efficacy and anxiety concerning gender and mathematics achievement. A quantitative approach was employed by disseminating a questionnaire to diploma students of Universiti Teknologi MARA (UiTM) Sarawak, who enrolled in the Pre-Calculus course (MAT133). The findings shows that students' Pre-Calculus result has a very strong association with their SPM Mathematic and SPM Additional Mathematics results, however, it was noticed that SPM Additional Mathematics associated stronger than SPM. Mathematics. It was also found that Pre-Calculus results and gender were strongly associated. Although there was no significant difference on the students' mathematics attitudes, self-efficacy and anxiety across gender, this study confirms that attitudes, self-efficacy and anxiety have a significant impact on the students' mathematics achievement. Moreover, the findings also reveal that there was a moderate positive significant relationship between students' mean scores for attitudes and self-efficacy. Nonetheless, there was a moderate negative significant relationship between students' mean scores for anxiety toward attitude and self-efficacy, which concludes that a positive attitude of students on mathematics will increase their self-efficacy and hence reduce their anxiety towards mathematics. The result from the multiple regression analysis suggests that students' attitude was the best predictor to students' achievement in Pre-Calculus courses. This study provides some insights that may be deemed useful, especially to those who teach mathematics at the tertiary level.

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INTRODUCTION

Mathematics is commonly known to be an arduous and challenging subject (Ablian & Paranga, 2022; Sarmah & Das, 2020). Despite the fact that mathematics is incredibly important, underachievement in mathematics has been a great concern globally for decades, including Malaysia. According to the Programme for International Student Assessment (PISA) result in 2018, Malaysia's average score (440) was lower than the Organisation for Economic Co-operation and Development (OECD) average score (489) (OECD, 2023). Besides, the result of Trends in International Mathematics and Science Study (TIMSS) on mathematics achievement in 2019 has shown a non-significant decrease in average score as compared to TIMSS 2015 (Ministry of Education Malaysia, 2023). Additionally, of the 373,974 candidates who sat for the Malaysia Certificate Examination or *Sijil Pelajaran Malaysia* (SPM) in 2022, 89,752 candidates (24.3%) failed SPM Mathematics, while 28,792 candidates (26.2%) failed SPM Additional Mathematics (Malaysia Examinations Syndicate, 2023).

Various factors related to students' mathematics achievement have been widely discussed in many studies. Besides intelligence or general cognitive ability (GCA), which are proven strongly associated with mathematics achievement (Giofrè et al., 2017; Soares et al., 2015), non-cognitive factors such as students' attitude (Kyllonen, 2012), self-efficacy (Carter, 2022) and anxiety (Lew & Hwang, 2019) towards mathematics seem to play an additional role to the mathematics achievement.

Researchers found that students' attitudes and self-efficacy play a critical role in their academic success in mathematics (Gjicali & Lipnevich, 2021; Du et al., 2021). If students have a good attitude toward mathematics, they are more likely to engage in educational activities and persevere in the face of challenges (Callaman & Itaas, 2020; Mazana et al., 2019). Strong self-efficacy beliefs in students also increase their propensity to set challenging goals for themselves and put out a significant effort to accomplish those targets (Julaihi et. al., 2022; Holenstein et. al, 2022).

Admittedly, students nowadays are lacking self-confidence and having fears while dealing with mathematics. When one's emotions are out of control, one may feel depressed and anxious, especially in learning mathematics (Cuder et al., 2023; Cipora et al., 2022; Caviola et al., 2022). Somehow this kind of feeling can be categorized as mathematics anxiety where one may face fear while solving any numeric related or performing any mathematical problem and this may directly affect their performance in mathematics (Caviola et al., 2022; Hill et al., 2016; Ashcraft, 2002). Researchers believe that this mathematics anxiety exists as early as early childhood (Cipora et al., 2022).

For a few decades, many universities around the world experienced a high failure rate in several mathematics courses, such as Pre-Calculus and Calculus. Universiti Teknologi MARA (UiTM) shared the same concern and a number of studies have been conducted which highlighted students' underachievement in Pre-Calculus and Calculus (Tang et al., 2010; Tang et al., 2013; Mohd Nasir et al., 2018). The poor performance of students in these courses have created prolonged dilemmas among the educators.

As there is limited research that has explored the predictive value of students' attitude, self-efficacy, and anxiety on mathematics achievement (Gjicali & Lipnevich, 2021, Burrus & Moore, 2016), this study is embarked to investigate these factors and their association. This study focuses on Pre-Calculus as this course contains the fundamentals of Calculus and it is a prerequisite of other advanced mathematics courses. Thus, it is essential to improve students' achievement in Pre-Calculus by examining the above-mentioned factors.

In this study, attitude towards mathematics is defined as the emotional dispositions associated with mathematics (Hannula, 2002); mathematics self-efficacy is defined as one's beliefs or perceptions with respect to their abilities in mathematics (Bandura, 1997); and, mathematics anxiety is defined as a feeling of tension and apprehension that interferes with mathematics performance ability, the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Khasawneh et al., 2021).

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Specifically, this study is conducted based on the following objectives:

1. to examine the students' mathematics achievement (Pre-Calculus result) across mathematics background (SPM Mathematics & SPM Additional Mathematics results) and gender.
2. to investigate the students' attitude, self-efficacy and anxiety towards mathematics.
3. to determine the correlation between students' attitude, self-efficacy and anxiety and their relationship with mathematics achievement.

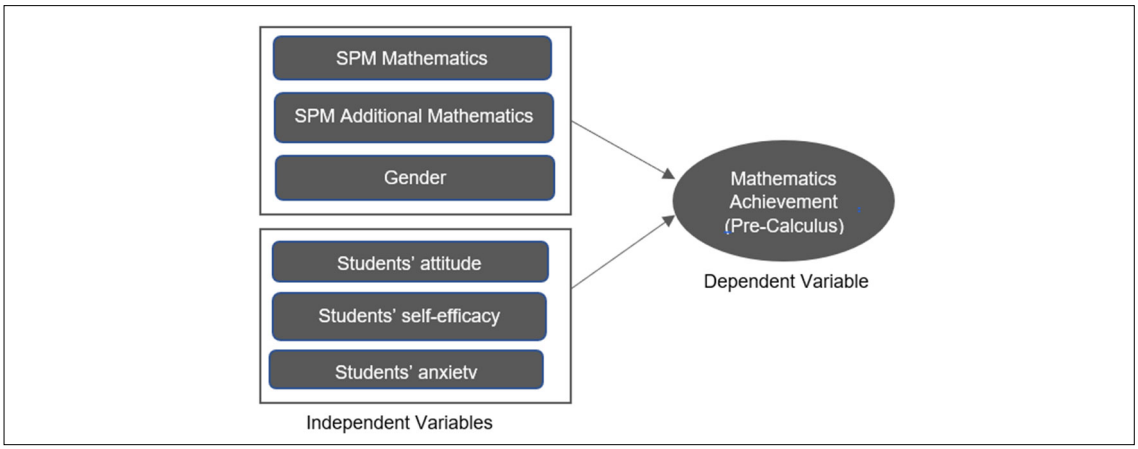

Fig. 1 Framework of the study

Figure 1 illustrates the framework of this study. It shows that mathematics achievement in Pre-Calculus (as a dependent variable) is related to a student's demographic information (such as gender, SPM Mathematics and SPM mathematics results) and student's non-cognitive factors (such as attitude, self-efficacy and anxiety).

LITERATURE REVIEW

Students' Underachievement in Mathematics

Various literatures reported that student's underachievement in mathematics involved multiple levels of studies around the world. General mathematics knowledge has been identified as an important variable to mathematics achievement in tertiary education (Yudariah & Roselainy, 1997; Gynnild et al., 2005). The insufficient basic mathematics skills were categorised as one of the crucial reasons for students to fail their tertiary level mathematics such as calculus courses (Gynnild et al., 2005).

Many studies revealed that undergraduate students did not perform in Mathematics courses (Mokhtar et al., 2019; Mohd Nasir et al., 2018; Tang et al., 2010). Underachievement in Pre-Calculus among undergraduate students is influenced by demographic factors such as gender (Caviola, et al, 2022; Levine & Pantoja, 2021), teacher factor, student factor and environmental factor (Mazana, et al, 2019; Suan, 2014). SPM Additional Mathematics grade was found to have significant influence on the students' mathematics performance (Mokhtar et al., 2019; Tang et al., 2010). This is supported by Yudariah and Roselainy (1997) that students who do not take or low-perform in SPM Additional Mathematics generally do not score a good grade in the first year Basic Mathematics and Basic Calculus at tertiary level. Tang et al. (2010) revealed that students' educational background and gender have significant high impact towards the underachieved Mathematics course marks and affect the students' academic performance. They added that

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the students who have only learned SPM Mathematics do not have sufficient mathematical problem-solving skills to explore more challenging and advanced mathematics at tertiary level. This is confirmed by Zakaria et al. (2016) that most of the engineering students who have low grades in mathematics indirectly influence their CGPA grade.

Students' attitude towards mathematics

Over the years, behavioural studies on students' attitudes have become increasingly relevant. As students' attitude has greatly influenced the students' success in mathematics learning, various aspects of students' attitudes have been researched in recent years (Gjicali & Lipnevich, 2021; Hwang & Son, 2021, Chen et al., 2018).

Several studies have reported that there are gender differences in attitude towards mathematics with girls showing more attitudes than boys in developed country (Eriksson, 2020), girls showing more negative attitudes than boys, (Dowker & Sheridan, 2022) and both genders showing similar positive attitudes towards mathematics (Moussa & Saali, 2022; Mazana et al., 2019; Kasimu & Imoro, 2017).

Although several researchers have reported a positive relationship between students' attitudes toward mathematics and mathematics achievement (Hwang & Son, 2021, Chen et al., 2018), others have reported a non-significant association between them (Sarmah & Das, 2020; Mubeen et al., 2013; Tang et al., 2013).

Students' mathematics self-efficacy

Many studies documented on self-efficacy has positive impact in students' academic performance (Ablian & Paranga, 2022; Carter, 2022), students' motivation (Margolis & McCabe, 2003), students' confidence (Landrum, 2020) as well as teaching and learning (Julaihi et al., 2020; Julaihi et al., 2022). Furthermore, mathematics self-efficacy has also been associated and identified as a better predictor of mathematics achievement (Carter, 2022; Prabawanto, 2018; Kyllonen, 2012). The implication of mathematics self-efficacy towards students' achievement in mathematics courses is well-documented, and has been confirmed in different contexts, cultures, and populations (Morán-Soto & Benson, 2018).

Some researchers found significant differences between the mathematics self-efficacy on students' gender, with males demonstrating significantly higher level of mathematics self-efficacy than female students (Hay, et al., 2022; Huang, 2013; Betz & Hackett, 1983; Pajares & Miller, 1994) or otherwise (Sevgi & Arslan, 2020; Yasemin, 2020). On the contrary, some researchers have found no gender differences in mathematics self-efficacy (Julaihi, et al., 2022; Kasturi et al., 2021).

Students' mathematics anxiety

Mathematics anxiety is a widespread phenomenon that impacts mathematical learning all over the world. The finding from Zakaria et al. (2016) reported that male students have the same anxiety level in mathematics as female students. Some research reported that female students tend to have higher levels of mathematics anxiety than male students on average (Dowker & Sheridan, 2022; Rodriguez et al, 2020; Pelch, 2018). On the contrary, some research found that there was no significant difference on the students' mathematics anxiety across gender (Zhang et al., 2019; Mazana et al., 2019), which concluded that there is an inconclusive result for the mathematics anxiety level across gender. On the other hand, some research revealed the negative relationship between mathematics anxiety and mathematics achievement (Ablian & Parangat, 2022; Ashcraft, 2002; Caviola, et al.,2022) and seems to be similar in both gender (Zhang et al., 2019; Caviola et al., 2022).

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METHODOLOGY

Quantitative data were collected via a google form questionnaire to gather the responses. The main focus of the questionnaire is to explore the students' attitude, self-efficacy and anxiety towards their achievements in mathematics and thus study the relationship between these factors.

The questionnaire was divided into 4 sections. Section A required the demographic profiles of the respondents. The demographic profiles enlisted the respondents' gender, programme, SPM subject package and the mathematics achievement.

Section B sought to obtain the respondents' feedback on their attitudes towards mathematics. Instrument for this section was adapted from Tang et al. (2013), where the numbers of items in Tang's questionnaire were reduced from 20 items to 17 items, due to their appropriateness in the context used. Besides, the term 'Calculus' in Tang's questionnaire was changed to 'Mathematics'. This section comprised of 7 positive statements and 10 negative statements (reverse-coded items), where the items were rated based on a 5-point Likert Scale: 1=Strongly Disagree, 2=Disagree, 3=Neither Disagree nor Agree, 4=Agree, 5=Strongly Agree.

Section C and D respectively sought to obtain the respondents' feedback on their mathematics self-efficacy and anxiety, specifically on the enrolled pre-calculus course, known as MAT133. Instrument for both sections was adapted from Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) which was developed by May (2009). The instrument has been significantly changed due to appropriateness to the study. Some items were rephrased according to the purpose of the study whereas only 10 from 13 items on self-efficacy and 10 from 15 items on anxiety were selected for this study. For both sections C and D, items were rated based on a 5-point Likert Scale: 1=Never, 2=Seldom, 3=Sometimes, 4=Often, 5=Usually.

To determine the feasibility of the research design, a pilot test was conducted on 30 students of Diploma in Computer Science from UiTM Sarawak campus. The reliability test of the domain was examined using Cronbach's Alpha which ranges in value from 0 to 1. As shown in Table 1, the reliability coefficients for all domains ranged between 0.907 to 0.939, suggesting strong internal consistency reliability for all domains.

Table 1. Cronbach's alpha of all domains

Domain	Num of Items	N	Mean	SD	Cronbach's Alpha
Attitude towards mathematics	17	30	3.276	0.575	0.907
Mathematics self-efficacy	10	30	3.407	0.265	0.927
Mathematics anxiety	10	30	3.313	0.239	0.939

The final instrument https://drive.google.com/file/d/1KfSZgr19aPl91iHgiLbCDZj67ivNc11-/view?usp=drive_link) was disseminated to all diploma students of Universiti Teknologi MARA (UiTM) Sarawak who took the Pre-Calculus course (namely MAT133) during October 2022 – February 2023 semester of study, via google form. The data collection was based on convenience sampling, where the link of the google form was circulated thru WhatsApp.

The data was analyzed by using Statistical Package for Social Sciences (SPSS). The data analysis included both descriptive and inferential statistics. Descriptive statistics such as frequency, percentage, mean, and standard deviation were generated to summarize and present the data. Meanwhile, inferential statistics which comprised the Independent T-Test (a parametric test) and Mann-Whitney U Test (a non-parametric test) were generated to make the possible inferences on the data. Moreover, a Pearson Chi-Square or Correlation and Multiple Regression were employed to investigate the correlation among independent variables as well as the relationship between dependent variable and independent variables.

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RESULTS AND DISCUSSION

Respondents' Profiles

226 diploma students from both the Diploma in Science (AS120) and the Diploma in Computer Science (CS110) of UiTM Sarawak participated in this study. Table 2 shows the demographic profiles of the respondents.

Table 2. Profiles of the respondents

Profiles	Total (Percent%)
Gender (n=226)	
Female	131 (58.0%)
Male	95 (42.0%)
Programme of Study (n=226)	
Diploma in Science (AS120)	124 (54.9%)
Diploma in Computer Science (CS110)	102 (45.1%)
SPM Subject Package (n=226)	
Arts and Humanities (non-STEM)	47 (20.8%)
STEM Package A & B (with Additional Mathematics)	142 (62.8%)
STEM Package C (no Additional Mathematics)	37 (16.4%)

As stated in Table 2, 131 (58.0%) of the respondents are females, and the remaining 95 (42.0%) are males. Meanwhile, 124 (54.9%) of the respondents are students from Diploma in Science (AS120) and the rest 102 (45.1%) are students from Diploma in Computer Science (CS110).

With regards to the subject package taken by the respondents for their SPM, 47 (20.8%) of them were from the Arts and Humanities Package (non-STEM) while the remaining 179 (79.2%) were from the STEM Package. To be specific, 142 (62.8%) of the respondents took the STEM Package with the Additional Mathematics subject, whereas 37 (16.4%) of them took the STEM Package without the Additional Mathematics subject.

Objective 1: To examine the students' mathematics achievement (Pre-Calculus result) across mathematics background (SPM Mathematics & SPM Additional Mathematics results) and gender

Table 3 and Table 4 present the overall mathematics results obtained by the respondents, which include SPM Mathematics, SPM Additional Mathematics and Pre-Calculus course. Table 3 indicates that 226 (100%) of the respondents passed SPM Mathematics, with at least grade C. However, out of 152 respondents who took SPM Additional Mathematics, only 16 (10.5%) got at least grade B, 27 (17.8%) with grade C+ or C, 71 (46.7%) got D or E, while remaining 38 (25.05%) failed the subject. In addition, 94 (41.6%) of the respondents failed the Pre-Calculus Course (MAT133), with an overall mark of 40 and below.

The chi-square statistic shown in Table 5 indicates that students' Pre-Calculus result was significantly associated ($p < .05$) with their SPM Mathematics and SPM Additional Mathematics results, as well as gender. The strength of the association between variables was given by the Phi coefficient and Cramer's V correlation. Although the association between Pre-Calculus result and both SPM Mathematics and SPM Additional Mathematics results were very strong ($r > .25$), it was noticed that SPM Additional Mathematics ($r = .719$) associated stronger than SPM Mathematics ($r = .579$). This finding is supported by Tang et al. (2010) which revealed that SPM Additional Mathematics had the strongest impact on Pre-Calculus, and it was also a good predictor of the course marks of underachieved Mathematics courses. Mokhtar et al. (2019) recommended that a strong grade in SPM Additional Mathematics should be considered in the intake requirement for the Science-based programmes. Having only a SPM Mathematics background is not enough for students to survive in advanced Mathematics of tertiary education.

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Table 3. Overall mathematics results

Mathematics Course	Total (Percent%)
SPM Mathematics (n=226)	
Distinction (A+,,A, A-)	145 (64.2%)
Super /High Credit (B+,B)	31 (13.7%)
Credit (C+, C)	50 (22.1%)
SPM Additional Mathematics (n=152)	
Distinction (A+,,A, A-)	1 (0.7%)
Super /High Credit (B+,B)	15 (9.8%)
Credit (C+, C)	27 (17.8%)
Pass (D,E)	71 (46.7%)
Fail (G)	38 (25.0%)
Pre-Calculus (MAT133) (n=226)	
75 to 100 marks (grade A-, A & A+) - Pass	31 (13.7%)
60 to 74 marks (grade B-, B & B+) - Pass	52 (23.0%)
50 to 59 marks (grade C+ & C) - Pass	49 (21.7%)
40 to 49 marks (grade D, D+ & C-) - Fail	44 (19.5%)
30 to 39 marks (grade E) - Fail	37 (16.4%)
0 to 29 marks (grade F) – Fail	13 (5.7%)

Table 4. Overall mathematics results by category (with/out SPM Additional Mathematics)

	With SPM Add. Math.			Without SPM Add. Math.	
Grade	Add Math	Math	Pre-Calculus	Math	Pre-Calculus
A+		5(3.3%)	1(0.7%)		
A		95(62.5%)	21(13.8%)	26(35.1%)	
A-	1(0.7%)	13(8.6%)	9(5.9%)	6(8.1%)	
B+	8(5.3%)	6(3.9%)	18(11.8%)	9(12.2%)	3(4.1%)
B	7(4.6%)	9(5.9%)	28(18.4%)	7(9.5%)	3(4.1%)
C+	15(9.9%)	12(7.9%)	12(7.9%)	15(20.3%)	5(6.8%)
C	12(7.9%)	12(7.9%)	22(14.5%)	11(14.9%)	10(13.5%)
C-			2(1.3%)		1(1.4%)
D+			6(3.9%)		10(13.5%)
D	31(20.4%)		18(11.8%)		7(9.5%)
E	40(26.3%)		11(7.2%)		26(35.1%)
F/G	38(25.0%)		4(2.6%)		9(12.2%)
Total	152	152	152	74	74

Table 5. Association between students' Pre-Calculus Result and SPM Mathematics, SPM Additional Mathematics and Gender

	Value	**df**	**Asymp. Sig. (2-sided)**
SPM Mathematics (n=226)			
Pearson Chi-Square	75.638	6	.000
Likelihood Ratio	80.587	6	.000
Phi/ Cramer's V	.579		.000
SPM Additional Mathematics (n=226)			
Pearson Chi-Square	116.853	9	.000
Likelihood Ratio	147.550	9	.000
Phi/ Cramer's V	.719		.000
Gender (n=226)			
Pearson Chi-Square	5.384	1	.020
Likelihood Ratio	5.379	1	.020
Phi/ Cramer's V	.154		.020

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On the other hand, Pre-Calculus results and gender were strongly associated (r > .15). As shown in Table 6, female students show a better performance in Pre-Calculus as compared to male students. This finding is consistent with Awang et al. (2021) and Tang et al (2009) who revealed that female students outperformed the male students in Pre-Calculus courses.

Table 6. Pre-Calculus Result across Gender

	Pre-Calculus Result (MAT133)		
Gender	Passed	Failed	Total
Male	47 (49.47%)	48 (50.53%)	95
Female	85 (64.89%)	46 (35.11%)	131
Total	132 (58.41%)	94 (41.59%)	226

Objective 2: To investigate the students' attitude, self-efficacy and anxiety towards mathematics

Test of Normality

A normality test was first performed before determining the suitable tests to be used in the analysis. The result shown in Table 7 indicates that the variable attitude was normally distributed (p > .05) while the other 2 variables were vice versa.

Table 7. Test of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
.050	226	.200*	.988	226	.055	.002
.080	226	.001	.980	226	.002	.002
.117	226	.000	.979	226	.002	

*This is a lower bound of the true significance.

Students' attitude towards mathematics

Students' attitudes were analysed based on the 17 items, on a 5-point Likert scale that assessed their attitudes toward mathematics. Since the data on students' attitudes were normally distributed, Independent T-Test was used to analyse the students' attitude across gender and MAT133 result. As depicted in Table 8, there was no significant difference (p > .05) on the students' attitudes toward mathematics across gender. This result confirms the findings by Farooq and Shah (2008) and Kaur (2017). The mean score result indicates female students ascribed more positively to the statements as compared to their male counterparts. This is consistent with the review by Ahmad Fauzi et al. (2005) that reported female students to have more positive attitudes toward Calculus.

Table 8. Result of Independent T-Test on the students' attitude across gender and Pre-Calculus result

	Attitude	N	Mean	SD	Levene's Test (Equality of Variances) (Sig.)	Independent t-test (Equality of Means) (Sig.2-tailed)
Gender	Male	95	3.338	.505	.218	.660
	Female	131	3.369	.541		
Pre-Calculus Result	Pass	132	3.430	.533	.302	.012
	Fail	94	3.252	.499		

On the other hand, there was a significant difference (p < .05) on students' attitude towards mathematics across the Pre-Calculus result. From the mean score results, students who passed Pre-Calculus seem to have a more positive attitude towards mathematics. This is consistent with Mullis et al. (2020) that stated students with a positive attitude toward mathematics tend to like mathematics, view it as a valuable subject and have confidence in engaging in the subject. Such students also put more time and effort into studying

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mathematics. The above finding is also supported by Mensah et al. (2013) who found a positive relationship between students' attitudes and achievement in mathematics.

Students' self-efficacy and anxiety toward mathematics

Students' mathematics self-efficacy and anxiety were both analysed based on 10 items, respectively. Since the assumption of normality was violated for these two variables, Mann-Whitney U Test was used to analyse the students' self-efficacy and anxiety between gender and Pre-Calculus results.

As shown in Table 9, the result indicates that there was no significant difference ($p > .05$) on students' mathematics self-efficacy across gender. The finding was supported by Julaihi et al. (2022), which reported that gender does not affect students' self-efficacy and thus it is not a predictor of students' self-efficacy toward mathematics. However, the mean rank indicates female students scored a higher mathematics self-efficacy level as compared to male students. A similar finding is reported by Sevgi and Arslan (2020) and Yasemin (2020) who found that female students' self-efficacy is higher than their male counterparts.

Meanwhile, there was no significant difference ($p > .05$) on the students' mathematics anxiety across gender. This finding is supported by Zakaria et al. (2016) who reported that there is no difference in the level of mathematics anxiety between male and female students. However, the mean rank indicates female students scored a higher mathematical anxiety level as compared to male students. This finding is consistent with Rozgonjuk et al. (2020), Dowker and Sheridan (2022) and Pelch (2018) who found that higher mathematics anxiety is associated with the female gender. Moreover, Pelch (2018) also reported that female students have faced problems interacting with their faculty, and their peer study groups, and they were also more likely to express a desire to avoid situations in which they might encounter negative academic emotions.

Table 9. Result of Mann-Whitney U Test on the students' self-efficacy and anxiety across gender

		Self-efficacy		Anxiety	
Gender	N	Mean Rank	Sum of Rank	Mean Rank	Sum of Rank
Male	95	106.06	10114	107.17	10181
Female	131	118.60	15537	118.09	15470
Mann-Whitney U		5554		5621	
Asymp. Sig. (2-tailed)		.167		.214	

As in Table 10, the result shows that there was a significant difference ($p < .05$) in students' self-efficacy toward their Pre-Calculus result. From the mean rank results, students who passed Pre-Calculus show a higher self-efficacy toward mathematics. This indicates that students who have higher self-efficacy tend to perform better in mathematics. This result is consistent with Ablian and Paranga (2022) and Carter (2022) who reported that self-efficacy has a positive impact on students' academic performance.

Table 10. Result of Mann-Whitney U Test on the students' self-efficacy and anxiety toward the Pre-Calculus result

		Self-efficacy	Anxiety
Pre-Calculus Result	N	Mean Rank	Mean Rank
Pass	132	122.44	105.63
Fail	94	100.94	124.55
Man-Whitney U		5023.5	5165.0
Asymp. Sig. (2-tailed)		.015	.031

On the other hand, there was also a significant difference ($p < .05$) in students' anxiety toward their Pre-Calculus result. According to the mean rank score in Table 10, students who failed seem to have a higher level of anxiety towards mathematics. This finding is supported by Ashcraft (2002) and Caviola, et al. (2022) who stated that mathematics anxiety can have a direct impact on students' mathematics performance.

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Objective 3: To determine the correlation between students' attitude, self-efficacy and anxiety and their relationship with mathematics achievement.

Correlation between students' attitudes, self-efficacy, and anxiety toward mathematics

Table 11 reveals that there was a moderate positive significant relationship between students' mean scores for attitudes and self-efficacy ($r = 0.476$, $p < .05$). Nonetheless, there was a moderate negative significant relationship between students' mean scores for attitudes and anxiety ($r = – 0.409$, $p < .05$) and also the mean scores between self-efficacy and anxiety ($r = – 0.439$, $p < .05$).

Table 11. Correlations between students' attitudes, self-efficacy and anxiety towards mathematics

		Attitudes	Self-efficacy	Anxiety
Attitudes	Pearson Correlation	1	.476**	-.409**
	Sig. (2-tailed)		.000	.000
	N	226	226	226
Self-efficacy	Pearson Correlation	.476**	1	-.439**
	Sig. (2-tailed)	.000		.000
	N	226	226	226
Anxiety	Pearson Correlation	-.409**	-.439**	1
	Sig. (2-tailed)	.000	.000	
	N	226	226	226

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

The positive correlation between students' mean scores for attitudes and self-efficacy indicates a positive impact between these two variables. In other words, a positive attitude of students toward mathematics will increase students' self-efficacy and vice-versa. This result agrees well with the findings by Firouzeh and Mahmoudi (2014), who found that mathematics self-efficacy has a direct impact on mathematics attitude. Moreover, Kundu and Ghose (2016) reported that there is a high association between students' attitude and their self-efficacy toward mathematics, and hence, a positive attitude towards mathematics can help students develop self-efficacy.

Meanwhile, a negative correlation between students' mean scores for anxiety toward attitudes and self-efficacy, which indicates an opposite impact of anxiety toward these two variables. The results reveal that students with high levels of anxiety tend to have low mathematics attitudes and self-efficacy. This finding is consistent with Rozgonjuk et al. (2020) and Firouzeh and Mahmoudi (2014) who reported that mathematics attitude and self-efficacy play crucial roles in mathematics anxiety. Hence, improving students' mathematics self-efficacy may help in the reduction of mathematics anxiety or vice-versa.

Relationship between students' mathematics achievement (Pre-Calculus result) and their attitudes, self-efficacy, and anxiety

Table 12,13 and 14 show the results of the multiple regression analysis, which was carried out to analyze the relationship between students' mathematics achievement (dependent variable) and their attitudes, self-efficacy, and anxiety (independent variable).

The regression model shown in Table 12 indicates that together, all three independent variables (i.e., anxiety, attitudes, and self-efficacy) explained 3.6% of the variance (R Square) in Pre-Calculus result. As the R square value was closer to 0, this regression model was not a perfect model to produce an overall predictive accuracy.

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Table 12. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	189[a]	.036	.023	.488

a. Predictors: (Constant), Attitude, Self-Efficacy, Anxiety

Table 13. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.967	3	.656	2.749	.044
	Residual	52.936	222	.238		
	Total	54.903	225			

Table 14. Coefficients

		Unstandardized Coefficients		Standardized Coefficient		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.319	.345		.925	.356
	Attitude	.007	.004	.121	1.560	.120
	Self-efficacy	.002	.006	.022	.282	.778
	Anxiety	-.005	.004	-.088	-1.161	.247

The output generated in Table 13 indicates that this regression model was statistically significant ($F(3, 222) = 2.749$, $p < .05$). The result suggests that students' attitudes, self-efficacy, and anxiety can be used to reliably predict the students' Pre-Calculus result. However, an examination on t- and p-values shown in Table 14 indicates that all the three independent variable coefficients were not statistically significant. As they have no relationship with the dependent variable, they may just have a coefficient that is very close to zero (relative to the standard error). Due to this finding, further regression analysis was carried out using the backward stepwise method and the results were represented by Table 15 to Table 18.

Table 15. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.188[b]	.035	.027	.487
3	.167[c]	.028	.024	.488

b. Predictors: (Constant), Anxiety, Attitude
c. Predictors: (Constant), Attitude

Table 16. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	1.948	2	.974	4.101	.018
	Residual	52.955	223	.237		
	Total	54.903	225			
3	Regression	1.539	1	1.539	6.462	.012
	Residual	53.363	224	.238		
	Total	54.903	225			

Table 17. Coefficients

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
2	(Constant)	.360	.313		1.150	.251
	Attitude	.121	.068	.129	1.786	.075
	Anxiety	-.056	.043	-.095	-1.312	.191
3	(Constant)	.056	.210		.264	.792
	Attitude	.157	.062	.167	2.542	.012

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Table 18. Excluded Variables

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
2	Self-efficacy	.022[b]	.282	.778	.019	.702
3	Self-efficacy	.050[c]	.667	.506	.045	.773
	Anxiety	-.095[c]	-1.312	.191	-.087	.832

From Table 15 to Table 18, it was observed that Model 3 fits the data well. In Model 3, only variable 'attitude' has been entered into the regression equation, and this variable explained 28% of the variance (R Square) in Pre-Calculus result. The other two independent variables (i.e., self-efficacy and anxiety) failed to meet the selection criteria, as indicated by the non-significant t-value ($p > .05$). This regression model was statistically significant [$F (1, 224) = 6.462$, $p < .05$] and it suggests that students' attitude was the best predictor to students' achievement in Pre-Calculus courses.

CONCLUSION

This study provides vital information regarding the undergraduate students' attitude, self-efficacy and anxiety concerning their mathematics achievement, specifically in the Pre-Calculus course. The result indicates that SPM Additional Mathematics is a good predictor to the course marks of underachieved Mathematics courses. Thus, it is recommended that the future intakes of university students into science-based programmes should have good grades in SPM Additional Mathematics.

The result of the study also shows that there was no significant difference in the students' mathematics attitudes, self-efficacy and anxiety across gender. This is consistent with the Sustainable Development Goal 4 (SDG 4) principle of gender equality in education. Providing male and female students with equal opportunities to excel in mathematics and related subjects contributes to closing the gender gap in STEM education and promoting equal access to high-quality education.

Additionally, this study found that there were significant differences in students' attitude, self-efficacy and anxiety towards mathematics across their Pre-Calculus result. This confirms that attitudes, self-efficacy and anxiety have influences in the students' mathematics achievement. This study also suggests that students with a positive attitude towards mathematics usually have high self-efficacy and low anxiety, and hence are able to increase their achievement in mathematics.

The correlation between students' attitudes, self-efficacy, and anxiety in mathematics emphasizes the need for a positive and supportive learning environment. Addressing students' attitudes and emotions towards mathematics can contribute to their success in acquiring mathematical abilities and improve their overall educational experience.

Last but not least, the result from the multiple regression analysis suggests that students' attitude was the best predictor to students' achievement in Pre-Calculus courses. Thus, it is important to improve students' attitude to increase their mathematics achievement. Continuous efforts should be made by educators to augment students' attitude towards mathematics as these would encourage them to achieve higher in the learning process. It is more meaningful if educators could design interventions that aim to enhance students' attitudes and self-efficacy in mathematics, thereby mitigating their anxiety associated with the subject.

This study provides vital information regarding the students' attitudes, self-efficacy and anxiety towards mathematics and some insights that may be deemed useful, especially to those who teach mathematics at the tertiary level. It is widely recognized that doing further studies in this area has the potential to expand understanding of the intricate relationship between students' attitudes, self-efficacy, and anxiety towards mathematics, as well as their influence on mathematics achievement. Future research might

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potentially incorporate a broader range of programs, encompassing a larger sample size derived from private universities and colleges, specifically focusing on those that provide Pre-Calculus courses.

LIMITATIONS OF THE STUDY

It should be noted that this study only involved diploma students from one public university. Therefore, caution must be taken when generalizing any findings of this study.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

The authors confirm the equal contribution in each part of this work. All authors reviewed and approved the final version of this work.

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