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A Quantitative Investigation of Student Engagement in Mathematics: Predictors and Group Variations Across Gender and Program

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ABSTRACT

This study investigates the influence of cognitive, affective, behavioural, and learning approach factors on student engagement in mathematics among higher education students. A total of 342 students enrolled in the Business Mathematics (MAT112) course at Universiti Teknologi MARA Cawangan Terengganu participated in the study. Data were collected using a 32-item questionnaire adapted from previous studies, measured on a five-point Likert scale. The instrument demonstrated good to very good internal consistency with Cronbach's alpha values ranging from 0.767 to 0.852. Data were analysed using Pearson correlation, independent samples t-test, one-way ANOVA, and multiple linear regression. The results revealed significant positive relationships between cognitive, affective, behavioural, learning approach, and student engagement. Female students demonstrated significantly higher engagement than male students, and engagement differed significantly across academic programmes. Multiple linear regression analysis identified affective and behavioural factors as the most influential predictors, followed by cognitive and learning approach factors. The regression model explained 64.1% of the variance in student engagement, indicating good explanatory power. These findings suggest that fostering positive attitudes, active participation, and effective learning approaches may enhance student engagement in mathematics across diverse student groups.

Keywords: Engagement, Cognitive, Affective, Behavioural, Learning Approach, Mathematics

INTRODUCTION

Student engagement has long been recognized as a critical factor influencing learning outcomes, academic achievement, and persistence in education. Engagement is especially important in mathematics education since students typically view mathematics as difficult and abstract. High engagement in mathematics is linked to deeper learning and academic success, while low engagement has been linked to anxiety, subpar performance, and negative attitudes. Consequently, understanding the elements that contribute to student engagement in mathematics remains an important field of educational research.

In addition to learning-related elements like study techniques and self-directed learning, student engagement is frequently seen as a multifaceted entity containing cognitive, affective, and behavioral components. Although prior studies have emphasized the significance of these aspects, their relative impact on total mathematical involvement has not been thoroughly investigated within certain academic environments.

Mathematical learning is a complex process (Moenikia & Zahed-Babelan, 2010). It comprises the development of logical reasoning, procedural fluency, conceptual understanding, problem-solving skills, and the ability to apply abstract ideas to real-world scenarios. Affective and cognitive factors both affect maths retention and comprehension (Sen, 2022). Affective aspects impact whether students engage deeply and effectively in mathematics, while cognitive factors govern how mathematics is processed and recalled. Math understanding and retention improve when both areas are addressed at the same time, fostering positive emotions, motivation, and confidence while fortifying cognitive abilities. High working memory and metacognitive skills can help students grasp and remember maths rules, unless they are overwhelmed by anxiety when faced with new tasks or assessments. The method by which pupils learn mathematics is therefore equally as significant as their exceptional comprehension of the subject (Cano & Berbén, 2009). A motivated student who has low anxiety, but weak memory and planning skills can still enjoy maths but find challenging to remember difficult ideas or work through difficult problems. This characteristic was given attention to math curricula when emotional factors that affected learning, like interest, attitudes, and perception, were recognised (Young et al., 2021).

Enhancing the efficacy of the teaching and learning process depends critically on students' engagement with mathematics (Pechenkina et al., 2017). Engaged students exhibit characteristics like active involvement, critical thinking, and tenacity, which not only improve understanding but also make teachers more flexible and effective. Students' involvement in mathematics acted as a mediator between their attitudes towards mathematics and their academic achievement (Carcueva, 2024). Positive perceptions of the course and the belief that it would enhance their academic success are more likely to be held by more involved students (Nayır, 2017).

Student engagement may also be influenced by contextual and demographic factors, such as academic program and gender, in addition to learning-related factors. Prior findings addressing gender differences in mathematics involvement are equivocal, and limited research has investigated program-based disparities in engagement. Designing instructional strategies that support a variety of student populations requires an understanding of these differences.

For students in the business stream at Universiti Teknologi MARA (UiTM) Cawangan Terengganu, MAT112 (Business Mathematics) is a required course. The goal of the course is to give students the analytical and mathematical abilities needed in the business and finance industries. However, anecdotal evidence and early scholarly verification have shown that most MAT112 students are anxious about the subject, perform poorly, and participate little in the class. Math anxiety, a tense or fearful feeling that impairs performance, affects a lot of students. This frequently results in avoidance behaviours, decreased participation, and detrimental effects on engagement, persistence, and self-confidence in math classes. Students that lack strong pre-tertiary preparation are frequently encountered by universities. These disparities lead to difficulties in more advanced maths classes, which in turn lowers engagement and increases the likelihood of failure. Comprehending the elements influencing students' engagement in this course is necessary for all these concerns.

Research demonstrates that there are several facets to student engagement, including behavioural, emotional, cognitive, and motivational elements (Fredricks et al., 2004). Additionally, the applied frameworks of mathematics courses typically do not pay enough attention to the integration of psychological and affective elements, such as motivation, achievement, and self-efficacy, as well as emotions, into the study of engagement. Lack of peer participation or like-minded study partners in maths can make some students feel lonely. Moreover, ineffective study techniques, a dependence on memorisation, motivational problems, and outside distractions are frequently mentioned by students as major barriers. Additionally, educators attribute these issues to inadequate curriculum designs and instructional strategies. Numerous studies demonstrate that even when female students score on par with or better than their male colleagues, they frequently express less confidence in their mathematics skills (Mejía-Rodríguez et al., 2021).

To reduce this gap, the current study investigates the factors that influence students' interest in mathematics as well as how engagement varies by gender and academic program. The following research questions serve as the study's compass:

The study is guided by the following research questions:

RQ1: What is the relationship between cognitive, affective, behavioral, and learning factors with student engagement in mathematics?

RQ2: To what extent do cognitive, affective, behavioral, and learning factors predict student engagement in mathematics?
RQ3: Are there significant differences in student engagement in mathematics based on gender?
RQ4: Are there significant differences in student engagement in mathematics across academic programs?

Based on the existing literature, the following hypotheses were formulated:

H1: Cognitive, affective, behavioral, and learning factors are significant predictors of student engagement in mathematics.
H2: There is a significant difference in student engagement in mathematics between male and female students.
H3: Student engagement in mathematics differs significantly across academic programs.

By addressing these research questions and hypotheses, this study intends to provide empirical data on the key factors of engagement in mathematics and offer insights that might inform instructional methods and program-level interventions.

LITERATURE

Student engagement is widely recognized as a key factor influencing academic achievement, learning quality, and persistence in education (Fredricks et al., 2004). Since mathematics is sometimes seen as challenging and abstract, which causes pupils to become anxious and disengaged, engagement is especially important in mathematics education (Ashcraft & Krause, 2007). Higher levels of engagement are regularly linked to superior academic achievement in mathematics, deeper learning, and enhanced problem-solving abilities (Skinner et al., 2009).

Student engagement is frequently conceptualized as a multifaceted construct, encompassing cognitive, affective, and behavioral components (Fredricks et al., 2004). More recent research has highlighted the significance of learning-related elements in maintaining engagement, especially in cognitively demanding courses like mathematics such as self-regulated learning and study techniques (Zimmerman, 2002).

Cognitive engagement refers to students’ commitment in learning which include their use of deep learning techniques, perseverance, and effort to grasp difficult concepts (Fredricks et al., 2004). Students who are intellectually engaged in mathematics are more likely to use problem-solving techniques, consider their mistakes, and pursue conceptual knowledge as opposed to mechanical memorization (Hiebert, 2003). Research has demonstrated that mathematical reasoning and accomplishment are positively correlated with cognitive engagement; nevertheless, the efficiency of this approach is frequently impacted by students' motivation and emotional reactions to learning (Pintrich, 2003).

Affective engagement encompasses students' feelings, attitudes, enthusiasm, and excitement in studying mathematics (Pekrun, 2006). Positive affective states, like enthusiasm and pleasure, have been established to increase perseverance and engagement, while negative emotions, such anxiety and failure-related fear, may limit engagement and performance (Ashcraft & Krause, 2007). Research continuously demonstrate that affective engagement is a key factor in maintaining students' interest in learning mathematics and is a powerful predictor of total engagement (Pekrun et al., 2011).

Behavioral engagement describes observable actions like participation, focus, commitment, and task completion (Skinner & Belmont, 1993). Behavioral engagement is a key factor in predicting learning outcomes and refers to students' visible involvement in learning activities, such as effort, perseverance, interaction with learning resources, and active participation in tasks (Wang & Eccles, 2012). Active problem-solving, class debates, and consistent effort on difficult assignments are examples of behavioral engagement in mathematics classes since behavioral engagement directly reflects students' participation in learning activities whereby previous research suggests that it is one of the best indicators of academic success and general engagement (Skinner et al., 2009).

Learning approach is another crucial element of student engagement which includes time management, self-control, and study habits. Self-regulated learners are more likely to organize, track, and assess their learning activities, which improves their mathematical engagement and academic success (Zimmerman, 2002). Effective approaches to learning may interact with cognitive and affective engagement to support long-term engagement and perseverance in mathematical learning (Pintrich, 2004). Research found that using interactive digital tools in teaching promote active learning and reduce cognitive load through visual and dynamic representations of concepts whereby it enhances students' engagement, attention, and learning in mathematics classrooms (Mayer, 2009; Schindler et al., 2017). The importance of instructional support in ensuring understanding and motivating students are also has been widely acknowledged as a critical factor in supporting student engagement, persistence, and academic performance (Ryan & Deci, 2000; Skinner et al., 2009).

Numerous studies have looked at gender variations in mathematical engagement, but the results are still conflicting. While some studies indicate little to no gender differences, others report that female students exhibit higher levels of engagement and learning persistence (Wang & Eccles, 2012). These inconsistencies imply that rather than acting as a key predictor, gender may have an indirect impact on involvement through motivating beliefs and learning experiences (Hyde et al., 2008). Research utilising TIMSS data, which includes more than 500,000 Grade 8 pupils from 50 nations, reveals that gendered trends in maths interest differ depending on the country. There is generally less interest in maths in high-achievement nations (like Sweden and Japan), and girls' interest tends to decline more precipitously. In contrast, girls tend to show more curiosity than boys in lower-achievement situations (like Oman and Malaysia). This tendency is explained by the fact that girls are more vulnerable to peer pressure, a phenomenon known as "female amplification" (Eriksson, 2020).

Student engagement is also significantly influenced by academic programs and learning environments. Students' interest and engagement in mathematics can be impacted by variations in curriculum structure, instructional methodologies, assessment techniques, and classroom atmosphere (Kahu, 2013). Higher levels of student engagement are typically fostered by programs that prioritize active learning, supportive teaching techniques, and meaningful application of mathematical concepts (Prince, 2004). Nevertheless, there are still few comparative studies looking at participation across academic programs, which emphasizes the need for more empirical research.

Overall, research suggests that a complex interaction of cognitive, affective, behavioral, and learning approach, together with demographic and environmental variables, affect students' engagement in mathematics. While earlier research has looked at these factors separately, fewer studies have looked at how they affect engagement when considered along with program and gender differences. With the goal to bridge this gap, the current study offers a thorough analysis of the factors that influence students' engagement in mathematics across various student groups.

METHODOLOGY

The population of this study consisted of all students enrolled in the Business Mathematics (MAT112) course at Universiti Teknologi MARA (UiTM) Cawangan Terengganu during the October 2024 to February 2025 semester. A total of 342 students participated in the study. Data were collected during Weeks 13 to 15 using a structured questionnaire comprising 32 items measured on a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

The questionnaire was developed by adapting relevant items from previous studies on student engagement and mathematics learning, particularly those related to cognitive, affective, behavioural, and learning approach constructs (Fredricks et al., 2004; Zimmerman, 2002; Pekrun, 2006; Skinner et al., 2009). The items were reviewed and modified to suit the context of the Business Mathematics (MAT112) course at UiTM Cawangan Terengganu.

The questionnaire was distributed online using Google Forms through the students' Telegram class and Google Classroom. The collected data were analysed using IBM SPSS Statistics version 28. Descriptive statistics were used to summarise the respondents' characteristics and responses. Pearson correlation analysis was conducted to examine the relationships among the variables. Independent samples t-test and one-way ANOVA were

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performed to determine differences in engagement based on gender and academic program, respectively. Finally, multiple linear regression analysis was employed to identify the significant predictors of student engagement in mathematics.

In this study, student engagement served as the dependent variable, while cognitive, affective, behavioural, learning approach, gender, and academic program were treated as the independent variables in the regression model.

RESULTS AND DISCUSSIONS

342 students from three programs at UiTM Cawangan Terengganu took part in the the survey. Diploma in Accountancy (AC110) students make up 45.3% of the responses, followed by Diploma in Investment Analysis (BA114) students at 29.8% and Diploma Muamalat (IC110) students at 24.9%. According to Table 1, 58.5% of the respondents are female and 41.5% are male.

Table 1. Demographics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	142	41.5
	Female	200	58.5
Program	AC110	155	45.3
	BA114	102	29.8
	IC110	85	24.9

The reliability of the item used to represent each of the variables is assessed using Cronbach's Alpha. As shown in Table 2, the scale's internal consistency reliability is very good, as indicated by the Cronbach's Alpha values for Cognitive (0.832), Affective (0.797), Behavioural (0.767), Learning Approach (0.852), and Engagement (0.836) being greater than 0.7 (Bougie & Sekaran, 2019). The consistency of the measured items for every variable is supported by the Cronbach's Alpha values.

Table 2. Summary of Cronbach Alpha

Variable	Items	Cronbach’s Alpha	Reliability
Cognitive	7	0.832	Very Reliable
Affective	8	0.797	Reliable
Behavioral	6	0.767	Reliable
Learning Approach	6	0.852	Very Reliable
Engagement	5	0.836	Very Reliable

Since the questionnaire was adapted from established studies, reliability analysis was conducted to evaluate the internal consistency of the modified instrument in the present context. As shown in Table 2, all constructs achieved Cronbach's alpha values above the recommended threshold of 0.70 (Bougie & Sekaran, 2019), indicating acceptable to very good internal consistency. These findings suggest that the adapted instrument was

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reliable for measuring cognitive, affective, behavioural, learning approach, and engagement constructs among Business Mathematics students.

Descriptive Statistics

Table 3. Descriptive Statistics

Item	Mean	Std. Deviation
How many hours do you spend on mathematics revision weekly?	1.96	.761
Mathematics is necessary for life	4.40	.664
In mathematics learning, it is very useful to memorize the methods for solving mathematics problems.	4.33	.721
When I learn mathematics, I would wonder how much the things I have learnt can be applied to real life.	4.15	.720
I would try to connect what I learned in mathematics with what I encounter in real life or in other subjects.	4.08	.732
I would use my spare time to study the topics we have discussed in class.	3.92	.736
The most effective way to learn mathematics is to follow the lecturer's instructions.	4.33	.697
I solve problems according to what the lecturer teaches.	4.37	.684
I find mathematics learning pleasurable.	4.07	.798
I am interested in studying mathematics	4.25	.805
I feel a sense of satisfaction when I do mathematics exercises in class.	4.29	.732
I feel excited when we start a new topic in mathematics.	4.03	.799
Though mathematics learning is tough, I feel happy when I can finish the tasks.	4.54	.625
Learning mathematics is tough, but to get good results, the effort is worthwhile	4.55	.638
I find myself very nervous during mathematics tests.	3.97	.964
I am always afraid that I will get poor results in mathematics tests.	4.28	.854
I am tired of learning mathematics.	2.47	1.122
I listen to the lecturer's instruction attentively.	4.23	.630
"I concentrate very hard when the lecturer introduces new mathematical concepts."	4.15	.710
I will use every means to understand what the lecturer teaches in mathematics.	4.26	.654
I always take part in the discussion in the mathematics class.	3.88	.797

I often procrastinate when it comes to revising mathematics.	3.43	1.004
For difficult problems, I would study hard until I understand them.	4.36	.677
Digital whiteboard helps me to feel less sleepy in class	3.62	.923
Digital whiteboard use makes it easier for me to remember what I learned in class	3.74	.853
I can focus on the course content more when digital Whiteboard is used	3.68	.866
I like to learn mathematics using digital whiteboard compared to traditional whiteboard	3.51	.953
My lecturer consistently ensures that I understand the subject matter.	4.22	.700
My lecturer frequently motivates me to excel in mathematics.	4.32	.670
I always take part in the discussion in the mathematics class.	3.87	.815
I like attending mathematics classes.	4.38	.674
I did not skipped my mathematics class	4.40	.759
If I make mistakes in solving problems, I will work until I have corrected them.	4.46	.634
I am always curious to learn new things in mathematics, and I find learning mathematics enjoyable.	4.26	.759

Based on Table 3, majority of the measures had mean values above 4.00 and relatively low standard deviations (SD ≈ 0.60–0.80), indicating both agreement and consistency among respondents. Overall, the results show highly positive attitudes and great involvement in learning mathematics. Students believe that learning mathematics is valuable despite its difficulties (M = 4.55, SD = 0.638) and firmly believe that mathematics is vital for life (M = 4.40, SD = 0.664). Additionally, they report a high level of intrinsic and achievement-related motivation when finishing mathematical tasks (M = 4.54, SD = 0.625).

Students clearly rely on lecturer supervision when it comes to learning tactics and classroom involvement. High mean scores were found for listening intently (M = 4.23, SD = 0.630), following the lecturer's directions (M = 4.33, SD = 0.697), solving problems in accordance with what is taught (M = 4.37, SD = 0.684), and making a concerted effort to grasp the content (M = 4.26, SD = 0.654). Students reported working hard on challenging problems until they understood them (M = 4.36, SD = 0.677) and fixing errors until they were fixed (M = 4.46, SD = 0.634), demonstrating persistence in particular. Moderate active involvement was indicated by slightly reduced but nevertheless good participation in class discussions (M = 3.87–3.88, SD ≈ 0.80).

In terms of affective aspects and learning difficulties, students often have a significant interest in mathematics (M = 4.25, SD = 0.805) and love it (M = 4.07, SD = 0.798). But there is also evidence of mathematics anxiety, as students reported feeling anxious during exams (M = 3.97, SD = 0.964) and fearing getting bad scores (M = 4.28, SD = 0.854). While feelings of tiredness toward learning mathematics are relatively low (M = 2.47, SD = 1.122), procrastination in mathematics review is reported at a moderate level (M = 3.43, SD = 1.004), suggesting that negative emotions do not overwhelm positive attitudes.

Lastly, students have a rather favorable opinion on the use of digital whiteboards. The mean scores for items pertaining to enhanced alertness, focus, and memory ranged from 3.51 to 3.74 (SD ≈ 0.85–0.95), indicating that although digital whiteboards encourage participation, they are not overwhelmingly favored over conventional techniques. Along with excellent attendance and dedication to lessons (M = 4.38–4.40, SD ≈ 0.67–0.76), lecturer support and inspiration were assessed favorably (M = 4.22–4.32, SD ≈ 0.67–0.70). Overall, the results show a cohort of motivated, hardworking students who had good learning experiences, bolstered by good teaching and modest technology advancement.

Students spend comparatively little time reviewing mathematics each week, as seen by the mean score of 1.96 with a standard deviation of 0.761. A mean score of 2 indicates that the majority of students fall within the response scale's lower categories, indicating little involvement in revision outside of class. Students' replies are generally consistent, with most reporting comparable amounts of revision time rather than significant individual variances, as indicated by the comparatively small standard deviation (SD = 0.761). Overall, this finding implies that although students may have favorable attitudes toward mathematics in the classroom, their amount of time spent independently reviewing outside of the classroom is rather little and does not significantly differ amongst individuals.

Correlation

Table 4. Correlation Analysis

		Gender	Program	Cognitive	Affective	Behaviour	Learning
Engagement	Pearson	.142**	-.134*	.688**	.698**	.718**	.514**
	Sig. (2-tailed)	.008	.013	<.001	<.001	<.001	<.001
	N	342	342	342	342	342	342

The associations between student engagement and the predictors; gender, program, cognitive, affective, behavioral, and learning factors were investigated using a Pearson correlation analysis. The findings showed a substantial correlation between engagement and all factors. Cognitive ($r = 0.688$, $p < .001$), affective ($r = 0.698$, $p < .001$), behavioral ($r = 0.718$, $p < .001$), and learning factors ($r = 0.514$, $p < .001$) were all positively correlated with engagement; the highest correlations were found between behavioral and affective factors. Engagement was substantially but moderately connected with gender ($r = 0.142$, $p = .008$) and program ($r = -0.134$, $p = .013$), indicating minor variations across demographic traits. These results suggest that students are more engaged when their cognitive, affective, behavioral, and learning scores are higher.

Independent t- test

Table 5: Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
Engagement	Female	200	4.3440	.51711	.03657
	Male	142	4.1803	.62265	.05225

Table 6: Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
Engagement	Equal variances assumed	1.552	.214	2.649	340	.004	.008	.16372	.06181	.04213	.28530
	Equal variances not assumed			2.567	267.463	.005	.011	.16372	.06377	.03815	.28928

Based on Table 5, female participants have a higher mean score (4.3440) than male participants (4.1803). This suggests that on average, female students engaged slightly higher in mathematics compared to male. The standard deviation for female is 0.51711 while the standard deviation for male is 0.62265. On the average, the engagement for the female students deviated as much 0.51711 from it mean of 4.3440 while the engagement for male students deviated as much as 0.62265 from it mean of 4.1803. This shows that the variability in engagement is greater among males than females.

An independent samples t-test was conducted to examine whether there was a significant difference in engagement levels between male and female participants (Table 6). Levene's Test for Equality of Variances indicated that the assumption of homogeneity of variance was met, $F(1, 340) = 1.552$, p-value = 0.214, allowing for the use of the equal variances assumed results. The study showed that the mean engagement scores for the two gender groups differed statistically significantly ($t(340) = 2.649$, p-value =.008 (two-tailed)). Compared to male participants (M = 4.1803, SD = 0.62265, N = 142), female participants (M = 4.3440, SD = 0.51711, N = 200) reported substantially higher levels of involvement. With a 95% confidence interval between 0.04213 and 0.28530, the average difference in engagement scores was 0.1637 points. Given that females in this group showed somewhat but considerably higher levels of involvement than males, these findings imply that gender significantly have an impact on engagement levels.

One way ANOVA

Table 7. One-Way ANOVA for Engagement Across Programs

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.756	2	1.378	4.352	0.014
Within Groups	107.347	339	0.317		
Total	110.103	341			

Note: Dependent variable = Engagement. $F(2, 339) = 4.352$, $p = 0.014$. Levene's test indicated equal variances across programs ($p = 0.214$).

Table 8. Post-hoc Comparisons (Tukey HSD) of Engagement Between Programs

(I) Program	**(J) Program**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
AC110	BA114	0.18988*	0.07175	0.023
AC110	IC110	0.16713	0.07595	0.073
BA114	IC110	-0.02275	0.08264	0.959

A one-way ANOVA ($F(2, 339) = 4.352$, $p = 0.014$) showed that the program had a substantial impact on engagement (Table 8). Students from AC110 were substantially more engaged than those in BA114 program, according to post-hoc Tukey HSD comparisons; however, there were no significant differences between AC110 and IC110 or between BA114 and IC110.

Multiple Linear Regression

A multiple linear regression analysis was conducted to examine the unique contributions of each predictor to engagement while controlling for the others.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.804[a]	.647	.641	.34066
a. Predictors: (Constant), Learning, Program, Gender, Affective, Behavioral, Cognitive				

Based on the Model Summary, the regression model demonstrated good explanatory power, with an Adjusted R^2 value of 0.641. This indicates that approximately 64.1% of the variation in student engagement was explained by the six predictors included in the model after adjusting for the number of predictors. This relatively high proportion of explained variance suggests that the selected predictors provide a meaningful explanation of student engagement in mathematics.

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	71.228	6	11.871	102.298	<.001[b]
	Residual	38.876	335	.116		
	Total	110.103	341			
a. Dependent Variable: Engagement						
b. Predictors: (Constant), Learning, Program, Gender, Affective, Behavioral, Cognitive						

The regression ANOVA indicated that the overall model was statistically significant, $F(6, 335) = 102.298$, $p < .001$. This finding confirms that the regression model provides a good fit to the data and that the predictors collectively explain a significant proportion of the variation in student engagement.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	Sig.	VIF
Constant	-.037	.194		-.188	.851	
Cognitive	.195	.059	.171	3.289	.001	2.567
Affective	.386	.057	.324	6.821	<.001	2.144
Behavioural	.374	.056	.338	6.713	<.001	2.412
Learning	.092	.036	.103	2.537	.012	1.555
Gender	.028	.039	.024	.699	.485	1.114
Program	-.019	.023	-.027	-.795	.427	1.060

The findings showed that learning variables ($B = 0.092$, $p = .012$), behavioral factors ($B = 0.374$, $p < .001$), cognitive factors (B = 0.195, p =.001), and affective factors (B = 0.386, p <.001) were all significant predictors of engagement. Program (B = -0.019, p =.427) and gender (B = 0.028, p =.485) were not significant predictors, suggesting that the other predictors in the model explained the minor associations seen for these variables. Diagnostics for multicollinearity showed no cause for worry (VIF < 2.6).

Based on the unstandardized regression coefficients, affective factors (B = 0.386) showed the largest positive effect on student engagement, followed closely by behavioural factors (B = 0.374). This suggests that improvements in students' affective and behavioural aspects are associated with higher levels of engagement in mathematics, while controlling for the other predictors in the model.

DISCUSSION

The study's findings suggest that learning, behavioral, affective and cognitive elements all have a significant impact on students' engagement in mathematics, with behavioral and affective aspects having the biggest effects. Higher levels of engagement were shown by students who actively participated in learning activities and had favorable attitudes toward mathematics. Cognitive understanding and learning strategies also contributed positively, but their influence was less, indicating that information by itself is insufficient to foster engagement in the absence of motivation and active participation. These results are consistent with earlier studies showing the multifaceted nature of engagement and the importance of behavioral participation and affective motivation for long-term participation in educational activities (Fredricks et al., 2004; Skinner & Belmont, 1993).

Furthermore, the regression model demonstrated strong explanatory power, explaining approximately 64.1% of the variation in student engagement. This suggests that the selected psychological and learning-related factors collectively provide a robust framework for understanding student engagement in mathematics. The findings further imply that strengthening students' attitudes, motivation, learning behaviours, and cognitive engagement may substantially enhance engagement in mathematics courses.

Significant variations in program engagement were also discovered by the study. While IC110 students showed intermediate levels of interest that were not substantially different from either group, AC110 students reported significantly higher levels of engagement than BA114 students. This may represent program-specific elements, such as differences in teaching styles, curriculum design, or peer dynamics, which can influence how students perceive and participate in learning. This is further supported by the Tukey HSD homogeneous subsets analysis, which highlights the biggest difference between AC110 and BA114 pupils by indicating that BA114 and IC110 constitute one subset and AC110 forms a different subset. These findings correspond with past studies demonstrating that contextual elements within academic programs might impact student involvement (Kahu, 2013; Reeve, 2013).

The result of the independent sample t-test revealed that male and female engagement levels differ statistically significantly where females reporting higher average engagement scores. In particular, the mean engagement score for male and female was 4.1803 and 4.3440, respectively. This is a small but statistically significant difference of almost 0.1637 points. The statistical significance (p =.008) and the confidence interval ([0.04213, 0.28530]) suggest that this pattern is unlikely to have happened by accident, despite the numerical difference appearing to be minor.

Gender-based differences in engagement have frequently been discovered in research, especially in academic or organisational settings where female may report higher levels of emotional, behavioural, or cognitive investment. Different motivations, communication styles, societal expectations, and the degree of inclusivity and support in situations could all be contributing factors. Females' higher involvement scores can indicate a greater fit with the goals, ideals, or approaches of maths education. According to certain research, female students are more likely to be conscientious, collaborative, and hard-working in classroom situations.

Several studies have found comparable gender-based different in a variety of circumstances, which is in line with the conclusion that female participants reported noticeably higher levels of engagement than male participants. Female students typically score better, especially on emotional and behavioural involvement whereby differences in classroom behaviour, socialisation, and motivation have been attributed for this

(Fredricks et al., 2004). Similar findings were made by Wang and Eccles (2012), who discovered that female were more likely than male to report high levels of involvement and that this engagement was associated with better academic achievement. Their research focused on how these distinctions are shaped by gendered socialisation and identity formation. However, gender was not a significant predictor in the multiple regression model, showing that attitudinal and behavioral elements are more relevant predictors of participation than demographic traits.

CONCLUSION AND RECOMMENDATIONS

This study evaluated the factors impacting student engagement in mathematics learning, with a specific focus on cognitive, affective, behavioral, and learning characteristics, as well as disparities across gender and academic programs. The results show that student engagement is a multifaceted concept that is influenced more by students' attitudes, habits, and methods of learning than by their demographics.

The results suggested that behavioral and affective elements were the biggest predictors of engagement, followed by cognitive and learning factors. This suggests that students are more likely to be highly engaged if they actively engage in learning activities and keep a good attitude about mathematics. While learning tactics and cognitive understanding can increase engagement, they seem to work best when combined with motivation and active participation. These findings underscore the necessity of nurturing both emotional and behavioral aspects of learning in mathematics education. Overall, the regression model demonstrated substantial explanatory power, indicating that cognitive, affective, behavioural, and learning approach factors provide a meaningful framework for understanding and enhancing student engagement in mathematics.

Program-specific variations in engagement were also noted. While students in IC110 showed intermediate levels of involvement, those in Program AC110 showed noticeably greater levels than those in BA114. These variations imply that student involvement may be impacted by program-specific circumstances, such as instructional strategies, curriculum design, or learning environments. Additionally, it was discovered that female students had somewhat greater levels of involvement than male students; however, the regression analysis did not find gender to be a significant predictor, suggesting that its impact is minimal in comparison to aspects associated to learning.

This study is limited by its cross-sectional design, which restricts causal interpretation of the links between learning elements and student involvement. The concentration on a single institutional environment restricts generalizability, and the use of self-reported metrics may create response bias. Future research should apply longitudinal or mixed-method techniques, involve more diverse samples, and study additional aspects such as teaching practices and classroom environment to enhance understanding of student engagement in mathematics. It's also critical to consider additional factors like age, cultural background, socioeconomic level, personality qualities, or experience that might have an impact on engagement.

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