Regression Analysis for Analyzing Students' Engagement in Mathematics at Higher Education Institution

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DOI: https://dx.doi.org/10.47772/IJRISS.2026.1026EDU0072

Received: 18 January 2026; Accepted: 23 January 2026; Published: 09 February 2026

ABSTRACT

This study investigates the influence of cognitive, affective and behavioral factors, as well as learning approach on higher education students' engagement in mathematics courses. The research was conducted with the involvement of all students enrolled in the Business Mathematics course at Universiti Teknologi MARA Cawangan Terengganu. A total of 342 students participated in the survey, comprising 200 females and 142 male students. Correlation and multiple regression analysis were used to examine the relationships between the study variables and student engagement in mathematics learning. The correlation analysis revealed significant positive relationships between student engagement in mathematics and all examined variables with behavioral aspects demonstrate the highest correlation with student engagement in mathematics learning. However, regression analysis indicates that the affective aspect is the most important factor that influences their engagement in Mathematics followed by behavioral, cognitive and learning approaches. These findings suggest that although observable learning behaviors are strongly associated with engagement, students' emotional factors play a more central role in sustaining engagement in mathematics learning. Hence, universities play a critical role to cultivate a conducive learning environment that supports students' mental well-being as this not only encourages pleasant emotional experiences but also increases engagement which leads to greater academic achievement throughout their studies.

Keywords*:* Engagement, Cognitive, Affective, Behavioral, Learning Approach, Students, Higher Education Institution, Mathematics

INTRODUCTION

The process of learning mathematics is multifaceted (Moenikia & Zahed-Babelan, 2010). It entails the growth of conceptual knowledge, procedural fluency, logical reasoning, problem-solving abilities and the capacity to apply abstract concepts to practical situations. Math comprehension and retention are influenced by both cognitive and affective aspects (Singh et al., 2002). Thus, the way in which students acquire mathematics is just as important as their remarkable understanding of the course matter (Cano & Berbén, 2009). Mathematics curricula were given significance with this feature when emotional aspects such as interest, attitudes and perception which influenced learning were observed (Leinwand et al., 2014). Recent research has focused on the impact of involvement, attitudes and learning styles on mathematics achievement, despite the challenge of modifying characteristics connected to home and family (Çağırgan & Soytürk, 2021).

Students' engagement in mathematics is critically essential for enhancing the effectiveness of both the learning and teaching process (Nayir, 2015). Active participation, critical thinking and perseverance are traits of engaged

students that not only increase comprehension but also help teachers become more adaptable and efficient. Academic achievement and attitudes towards mathematics were mediated by students' engagement in mathematics (Lijie et al., 2020). Higher engaged students are more likely to have favourable opinions about the course and believe that it will improve their academic performance (Nayir, 2015).

In Universiti Teknologi MARA (UiTM) Cawangan Terengganu, MAT112 (Business Mathematics) is a mandatory course for business stream students. The subject aims to equip students with the requisite mathematical and analytical skills required in the business and financial sectors. Anecdotal evidence and early scholarly documentation, nevertheless, have indicated that many students in MAT112 have low participation, poor performance and anxiety about the subject. All these issues call for understanding the factors affecting student engagement in this course. Literature indicates that student engagement is multi-faceted and encompasses behavioral, emotional and cognitive aspects (Fredricks et al., 2004). Many studies conceptually acknowledge learning approaches but do not empirically test them within engagement models. The integration of learning approach as a separate component of engagement is still under-theorized and under-validated. Few studies empirically examine how strategic learning approaches differentially predict specific dimensions of engagement, rather than engagement as a global construct. Furthermore, there is limited evidence on how the relationship between learning approaches and engagement operates across different disciplines, institutional types, or cultural contexts, limiting generalizability. Hence, this study aims to validate a four-dimensional engagement framework that includes cognitive, affective, behavioral, and learning approach dimensions by empirically examining student engagement among undergraduates enrolled in Business Mathematics at UiTM Cawangan Terengganu.

LITERATURE REVIEW

Student engagement in mathematics has also been identified as one of the key drivers of academic achievement especially in the higher education setting in which students are given more responsibility to undertake their learning processes. Engagement is a complex construct that involves cognitive, affective, behavioral and motivational aspects that combine to form the way students interact with mathematical material and can go about classroom experiences (Fredricks et al., 2004; Joshi et al., 2022). This problem is particularly important in Malaysia where the population of universities both public and private still requires providing educational services to students with different academic backgrounds and levels of readiness.

Cognitive involvement is a basic measure to define the extent and scope of the processing, understanding and use of mathematical concepts by students. Students with strong cognitive engagement skills will always demonstrate improved reasoning and problem-solving skills as well as the ability to relate mathematical concepts to real-life situations. As an example, Azizan et al. (2023) indicated that students who had high mathematical self-confidence were more prone to being cognitively involved as well as active learners. On the same note, it was discovered by Betrice et al. (2022) that when students have the freedom to work on their own and to connect mathematical constructions with real business situations, it enhances their capacity to think, especially in online learning platforms. These empirical findings support the evidence of the more recent study that cognitive engagement can affect other types of engagement, thus supporting its primary role in mathematics education (Joshi et al., 2022).

The affective aspect of engagement in mathematics refers to learners' emotions, attitudes and motivation that shape their engagement and persistence in learning mathematics. Involvement is not just limited to cognition since emotional reactions like pleasure, interest, self-assurance and nervousness have a far-reaching impact on the motivation and willingness to take part in the learning process by the learners. Good moods generally lead to increased attention and bad feelings, especially anxiety may slow down the performance. Alpaslan and Ulubey (2021) have proven that achievement emotions were a substantial predictor of student motivation and classroom interaction. Similarly, in a meta-analysis, Zhang et al. (2021) found out that mathematical anxiety is tightly linked with decreased performance and lower attendance in classrooms. In addition, Pei et al. (2025) established that anxiety and performance relate to the mediating role of engagement, which implies that the development of positive emotional experiences may alleviate the negative impact of anxiety. Amiruddin et al. (2022) identified that students who had greater confidence levels had lower anxiety rates and were more participatory in online education and thus, emotional preparedness is essential in influencing engagement in online learning.

Observable behaviors which are manifested in behavioral engagement, include effort, attentiveness, persistence and participation. Behaviorally engaged students have higher chances of finishing tasks, participating in conversations and being persistent in the activities despite being challenged by something in instruction. Experimental research has repeatedly indicated that there is a close connection between behavior involvement and math performance. The study by Maamin et al. (2022) found the following predictors of the performance in mathematics to be the strongest among Malaysian secondary students: emotional and behavioral engagement. Similarly, Muda@Yusof et al. (2019) also found that interactive and student-based methods of teaching students at the university brought better results. Those results highlight the importance of long-term consistency and engagement as the key to achievement in applied mathematics as a MAT112 course.

The learning approach which is the learning strategies that students obtain in their learning; these can be superficial memorization or more analytical processing. This dimension also refers to the effects of instructional environments on the strategies of learning of the students. Research indicates that technology enhanced and student-based pedagogies can go a long way to empower learning strategies. As an example, Lo and Hew (2021) discovered that the flipped classroom designs enhanced behavioral, emotional and cognitive engagement due to enhanced autonomy and collaboration in learning. Furthermore, Joshi et al. (2022) found that digital tools help in increasing engagement when they are actively incorporated in a properly designed pedagogical activity as opposed to passively. The self-regulated learners also demonstrate more persistence and reduced anxiety in the online learning environments (Amiruddin et al., 2022) which supports the necessity of effective learning strategies to be supported in mathematics courses.

Lastly, student engagement is seen as the result of cognitive, affective, behavioral and learning-approach factors. Engagement can be described as more than just participation, but it is the extent to which the students are putting their minds, hearts and actions into learning. According to the accumulating amount of literature, engagement is a predictor and a cause of academic achievement. An example is Maamin et al. (2022) and Muda@Yusof et al. (2019), who both concluded that the greater a student is engaged, the better they perform in mathematics. In addition, recent research indicates that affective and behavioral variables can have the strongest direct effect on total engagement (Zhang et al., 2021; Pei et al., 2025), which predetermines the significance of emotional support and active learning in mathematics teaching. Although there is a body of research on these dimensions, scanty studies have thoroughly examined these dimensions in applications mathematics programs like MAT112 in Malaysian universities. The current research, therefore, seeks to fill this gap by investigating the influence of the variables on engagement in a combined way and how the results can be used to implement more effective teaching methods.

METHODS

This study employed a quantitative survey design to investigate the relationship between students' cognitive, affective, behavioural, learning approaches and their engagement in mathematics courses. Quantitative methods were selected to enable objective measurement of variables, establish reliability and validity of instruments and examine associations using statistical techniques (Creswell & Creswell, 2018).

The population of this study is all students taking Business Mathematics (MAT112) course at UiTM Cawangan Terengganu in October 2024 to February 2025. There are 342 students involved with the survey. The survey is carried out from week 13 to 15 of the semester. A set of questionnaires which consist of 33 items with 5-Likert scale (1 = strongly disagree to 5 = strongly agree) were distributed to the students. The questionnaire which includes variables, was used to investigate the students' cognitive, affective, behavioral and learning approach towards students' engagement in mathematics. The instrument was designed based on validated scales from previous studies on student engagement and learning approaches. It included five dimensions which are cognitive, affective, behavioral, learning approach and students' engagement. Cognitive factor measured by seven items measuring how students relate the process of thinking and reasoning about mathematical concepts then apply the knowledge to real life situations. Affective factors measured by nine items include emotional, attitudinal and motivational aspects of a student's experience with learning mathematics. Six items are used to evaluate the behavioral factor which measures students' actions, attitudes, completion of assignments and patterns of involvement when learning and applying mathematical ideas. Learning Approach evaluated by six items capturing students' preferred strategies or method of acquiring knowledge. Lastly, Students' Engagement

used five items measuring students' level of involvement, commitment and connectedness to the mathematics course. The questionnaire is developed by using google form and distributed online to all the respondents by using Google Classroom via telegram class.

The data collected were then analyzed using SPSS 29.0 packet program. Descriptive statistics are used to summarize the data. Correlation analysis is used to determine the relationship between the variables. Then, Multiple Linear Regression is used to determine the factors that influenced the dependent variables. The hypothesis developed in this study to find the relationship between identified variables that may contribute to engagement are:

H1: Cognitive is positively related to Engagement

H2: Affective is positively related to Engagement

H3: Behavioral is positively related to Engagement

H4: Learning Approach is positively related to Engagement

RESULTS

In the survey, 342 students from three programs in UiTM Cawangan Terengganu participated. Almost half of the respondents are from Diploma in Accountancy (AC110) students (45.3%), 29.8% from Diploma in Investment Analysis (BA114) while 24.9% are from Diploma Muamalat (IC110). 58.5% of the respondents are female while another 41.5% of them are male as shown in Table 1.

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

Cronbach's Alpha is used to determine the reliability of the item used to represent each of the variables. As can be observed in Table 2, the Cronbach's Alpha values for Cognitive (0.832), Affective (0.797), Behavioral (0.767), Learning Approach (0.852) and Engagement (0.836) are greater than 0.7 suggesting very good internal consistency reliability for the scale used as suggested by (Bougie & Sekaran, 2019). The Cronbach's Alpha values support that there is a consistency of measured items for all variables.

Table 2. Summary of Cronbach Alpha

Variable	Items	Cronbach's Alpha	Reliability
Cognitive	7	0.832	Very Reliable
Affective	9	0.797	Reliable
Behavioral	6	0.767	Reliable
Learning Approach	6	0.852	Very Reliable
Engagement	5	0.836	Very Reliable

Descriptive Statistics

Table 3 below exhibits the mean of each item measures for cognitive with ratings ranging from 3.92 to 4.40 on a 5-Likert scale. The results show that students generally have a positive attitude toward mathematics and its importance to students' life. The assertion that mathematics is essential to life has the highest agreement (M = 4.40, SD = 0.664) indicating that pupils understand its practical significance. Likewise, measures pertaining to memorizing problem-solving techniques (M = 4.33, SD = 0.721), adhering to the instructional guidance such as lecturer's directions (M = 4.33, SD = 0.697) and guidance from their lecturers (M = 4.37, SD = 0.684) also had high mean scores suggesting a significant preference for structured learning methodologies. On the other hand, the slightly lower means for using free time for self-study (M = 3.92, SD = 0.736) and connecting mathematics to real-life applications (M = 4.08, SD = 0.732) indicate that although students value independent learning and practical application, these behaviors are less valued than structured classroom guidance. The comparatively modest standard deviations show that student responses generally follow a regular trend.

Table 3. Summary Measures for Cognitive

Item	Mean	Std. Deviation
Mathematics is necessary for life	4.40	0.664
In mathematics learning, it is very useful to memorize the methods for solving mathematics problems.	4.33	0.721
When I learn mathematics, I wonder how much the things I have learnt can be applied to real life.	4.15	0.720
I would try to connect what I learned in mathematics with what I encounter in real life or in other subjects.	4.08	0.732
I would use my spare time to study the topics we have discussed in class.	3.92	0.736
The most effective way to learn mathematics is to follow the lecturer's instructions.	4.33	0.697
I solve problems according to what the lecturer teaches.	4.37	0.684

Table 4 below shows that most mean scores above 4.0 which indicate interest, contentment and enjoyment in studying the subject, the results show that students generally have a good attitude toward learning mathematics. Students especially agree that working hard to get good outcomes (M = 4.55, SD = 0.638) and finishing difficult activities (M = 4.54, SD = 0.625) are satisfying, demonstrating a strong sense of desire and persistence. Additionally, they report feeling engaged (M = 4.25, SD = 0.805) and satisfied (M = 4.29, SD = 0.732) when studying mathematics, although their enthusiasm for new subjects is somewhat lower (M = 4.03, SD = 0.799). Their overall positive engagement does not appear to be outweighed by their moderate concern during tests (M = 3.97, SD = 0.964) and dread of negative outcomes (M = 4.28, SD = 0.854), which indicate the presence of anxiety. Notably, many students deny that they are tired of studying mathematics (M = 2.47, SD = 1.122), indicating that the group's level of burnout or exhaustion is low.

Table 4. Summary measures for Affective

Item	Mean	Std. Deviation
I find mathematics learning pleasurable.	4.07	0.798
I am interested in studying mathematics	4.25	0.805
I feel a sense of satisfaction when I do mathematics exercises in class.	4.29	0.732

I feel excited when we start a new topic in mathematics.	4.03	0.799
Though mathematics learning is tough, I feel happy when I can finish the tasks.	4.54	0.625
Learning mathematics is tough, but to get good results, the effort is worthwhile	4.55	0.638
I find myself very nervous during mathematics tests.	3.97	0.964
I am always afraid that I will get poor results in mathematics tests.	4.28	0.854
I am tired of learning mathematics.	2.47	1.122

According to Table 5, students show a generally high degree of interest and focus on mathematics lessons. They indicate a proactive learning approach by reporting high agreement with paying close attention to the lecturer (M = 4.23, SD = 0.630), focusing on new ideas (M = 4.15, SD = 0.710) and making every effort to comprehend the content (M = 4.26, SD = 0.654). Furthermore, the students are willing to work harder to solve challenging issues (M = 4.36, SD = 0.677). While students are focused during instruction, there may be some difficulties with active participation and independent study habits, as evidenced by the somewhat lower participation in class discussions (M = 3.88, SD = 0.797) and the moderate tendency to delay revising (M = 3.43, SD = 1.004). These patterns are generally highly stable throughout the group, as evidenced by the comparatively low standard deviations.

Table 5. Summary measures for Behavioral

Item	Mean	Std. Deviation
I listen to the lecturer's instructions attentively.	4.23	0.630
I concentrate very hard when the lecturer introduces new mathematical concepts.	4.15	0.710
I will use every means to understand what the lecturer teaches in mathematics.	4.26	0.654
I always take part in the discussion in the mathematics class.	3.88	0.797
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	0.677

Results in Table 6 shows that students' opinions of using digital whiteboards for mathematics are only moderately favorable. Although their preference for digital whiteboards over traditional ones is significantly lower (M = 3.51, SD = 0.953), they largely agree that they assist them stay awake (M = 3.62, SD = 0.923), enhance focus (M = 3.68, SD = 0.866) and aid in recalling class content (M = 3.74, SD = 0.853). In contrast, students show strong agreement regarding their lecturer's role in supporting learning, with high means for ensuring understanding (M = 4.22, SD = 0.700) and providing motivation to excel in mathematics (M = 4.32, SD = 0.670). This suggests that while technology moderately enhances engagement and learning, the lecturer's guidance and encouragement remain the most influential factors in students' learning experiences.

Table 6. Summary measures for Learning Approach

Item	Mean	Std. Deviation
Digital whiteboard helps me to feel less sleepy in class	3.62	0.923
Digital whiteboard use makes it easier for me to remember what I learned in class	3.74	0.853

I can focus on the course content more when digital Whiteboard is used	3.68	0.866
I like to learn mathematics using digital whiteboard compared to traditional whiteboard	3.51	0.953
My lecturer consistently ensures that I understand the subject matter.	4.22	0.700
My lecturer frequently motivates me to excel in mathematics.	4.32	0.670

The findings from Table 7 demonstrate that students' involvement and dedication to learning mathematics are generally favorable. They strongly agree that they like mathematics classes (M = 4.38, SD = 0.674) and do not skip them (M = 4.40, SD = 0.759), indicating that the students place a high importance on attending classes. Students also demonstrate perseverance and responsibility in learning with a high mean for correcting mistakes when solving problems (M = 4.46, SD = 0.634) and maintaining curiosity and enjoyment in learning new mathematics concepts (M = 4.26, SD = 0.759). Despite students being driven and dedicated, active verbal engagement is less consistent as seen by the slightly reduced participation in class discussions (M = 3.87, SD = 0.815).

Table 7. Summary measures for Engagement

Item	Mean	Std. Deviation
I always take part in the discussion in the mathematics class.	3.87	0.815
I like attending mathematics classes.	4.38	0.674
I did not skip my mathematics class	4.40	0.759
If I make mistakes in solving problems, I will work until I have corrected them.	4.46	0.634
I am always curious to learn new things in mathematics, and I find learning mathematics enjoyable.	4.26	0.759

Correlation

Correlation is then analyzed to determine whether there is a significant relationship between cognitive, affective, behavioral and learning approach with students' engagement. Pearson correlation is then being used since all the variables are quantitative variables. The correlation coefficient which has values between -1 and +1, is the final product of a correlation analysis. A correlation coefficient of zero means that there is no linear relationship between the two variables under study, a correlation coefficient of +1 means that the two variables are perfectly related in a positive (linear) manner and a correlation coefficient of -1 means that the two variables are perfectly related in a negative (linear) manner (Gogtay & Thatte, 2017).

Table 8 shows the result of Pearson correlation analysis. There is a significant moderate positive linear correlation between Engagement with all the four variables being studied. The correlation between Cognitive and Engagement is significant (p-value=<0.001 < α=0.01) with moderate positive linear relationship (r=0.688). Therefore, hypothesis 1 is accepted indicating that there is a correlation between Cognitive and students' engagement in mathematics. Correlation between Affective and Engagement is significant at α=0.01 with a moderate positive relationship (r=0.698). The same goes for the relationship between Behavioral and Engagement where there is also a moderate positive linear relationship among the two variables (r=0.718) and is significant at α=0.01. Therefore, hypotheses 2 and 3 are accepted indicating that there is a relationship between Affective and Behavioral towards Engagement. Lastly, there is a moderate linear relationship between Learning Approach and Engagement (r=0.718) and is significant at α=0.01. Therefore, hypothesis 4 is accepted indicating that there is a relationship between the learning approach and students' engagement.

Table 8. Summary of Correlation for Satisfaction

Variable	Pearson Correlation, r	Strength of Relationship	p-value
Cognitive	0.688**	Moderate	<0.001
Affective	0.698**	Moderate	<0.001
Behavioral	0.718**	Moderate	<0.001
Learning Approach	0.514**	Moderate	<0.001

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

Regression Analysis

Multiple Linear Regression was then analyzed to summarize the relationship between Cognitive, Affective, Behavioral and Learning Approach with Engagement. A Multiple Linear regression estimates the relationship between a response variable, *y* and more than one of explanatory variables, *x*. The approach does not allow for causal inferences but rather examines the relationship between explanatory variables and a response variable (Tranmer & Elliot, 2008).

Table 9 shows the multiple regression analysis for this study. The result of the overall correlation shows that there is a moderate (R=0.803) linear relationship between independent variables (Cognitive, Affective, Behavioral and Learning Approach) with students' engagement in mathematics. Coefficient of determination value, R^2 indicates that 64.6% of the variation in Engagement can be foreseen by Cognitive, Affective, Behavioral and Learning Approach. In contrast, the remaining 35.4% comes from another factor that is not in the model. The overall model is also significant with p-value = 0.000 ($F = 153.471$, $p < 0.001$). Regression analysis proves that independent variable Cognitive (Beta=0.193, p-value=0.001 < 0.01), Affective (Beta=0.404, p-value=<0.001 < 0.01), Behavioral (Beta=0.374, p-value=<0.001 < 0.01) and Learning Approach (Beta=0.086, p-value=<0.017 < 0.05) are all significant variables that contribute to engagement in Mathematics. Based on the value of the Beta, the most influential factor that contributes to students' engagement is Affective, followed by Behavioral, Cognitive and Learning Approach. Overall, the results show that pleasant emotions, active behaviors, higher degrees of cognitive involvement and improved learning strategies contribute to higher levels of student engagement.

Table 9. Multiple Linear Regression

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.803[a]	0.646	0.641	0.34028
a. Predictors: (Constant), Cognitive, Affective, Behavioral and Learning Approach				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	71.082	4	17.771	153.471	<.001[b]
	Residual	39.021	337	.116		

	Total	110.103	341			
a. Dependent Variable: Engagement						
b. Predictors: (Constant), Cognitive, Affective, Behavioral and Learning Approach						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.068	.178		-.379	.705
	Cognitive	.193	.059	.169	3.259	.001
	Affective	.404	.054	.339	7.472	<.001
	Behavioral	.374	.056	.339	6.738	<.001
	Learning	.086	.036	.096	2.397	.017
a. Dependent Variable: Engagement						

DISCUSSION

Engagement in a mathematics course is a key indicator of a student's ability to learn the subject. It involves various factors including cognitive, behavioral and affective dimensions. Learning approaches have proven to be one of the factors that influence student engagement in mathematics. The objectives of this study are to determine the relationship between these four variables: Cognitive, Affective, Behavioral and Learning approaches with the student's engagement in learning mathematics. The questionnaire has been constructed in four sections. To identify the relationship between Engagement with these four variables, there are 33 items that are measured. In this study, Cronbach's alpha is used to measure the internal consistency, and it found that from analysis there is a consistency of measured items for all variables (Cronbach's Alpha > 0.7). Behavioral aspects demonstrate the highest correlation with student engagement in mathematics learning. Focused attention on the instructor and lesson content appears to facilitate active participation in class. This focus also reflects their willingness to invest effort in understanding difficult challenges which further enhance their engagement in learning mathematics. A study conducted among secondary school pupils in Selangor, Malaysia found that behavioural engagement which includes attention, persistence and activity was associated with better performance in mathematics. According to Maamin et al. (2021) the increase of 0.585 points in the mathematics achievement score is related to the increase of behavioural involvement. This indicates that learners who are more diligent and attentive in mathematics perform better.

Affective factors tend to be positively correlated with engagement. Positive feelings such as satisfaction when solving difficult problems in mathematics significantly boost students' engagement in the subjects. Solving a problem which is difficult, increases students' self-esteem and inspires them to take on new challenges. Researchers studying educational psychology have found that positive emotions like enjoyment and pride significantly affect the motivation and performance of the students in mathematics. Research shows that love of arithmetic positively contributes to children's math achievement because it fosters self-regulation, intrinsic motivation, and persistence throughout learning tasks (Lin et al, 2020).

There is also a moderate positive correlation of engagement with cognitive aspects and learning approaches. Students who are actively thinking and engaged with their study content are more likely to use critical thinking for in-depth learning and persistence on difficult issues to improve academic performance. When lecturers

connect maths to the real world and encourage independent learning, then the students tend to get actively involved in the subject. In this research, the lecturers implemented a digital whiteboard in mathematics lessons, and the findings indicate that its use moderately enhances student engagement in mathematics. Students had a positive response towards the implementation of the digital whiteboard in the maths classroom. Compared to traditional teaching aids, the digital whiteboard made classroom activities more participatory by enhancing students' focus, alertness and recollection of course content. It particularly provides an advantage through enhancing students' understanding of the subject, allowing them to do meaningful learning, perform an active participation in classes, causing enhancement in their concentration and saving time (Önal, 2017).

CONCLUSION

This study systematically investigated the relationships between higher institution education students' engagement in mathematics with their cognitive aspect, affective, behavioral and learning approaches. From the correlation analysis, the study found that there is a moderate positive linear correlation between students' engagement in mathematics with each of the variable measures: cognitive, affective, behavioral and learning approach. This suggests that more effective mental preparation, happy feelings, active participation and strategic learning behaviours are all generally linked to higher levels of engagement. This association also highlights how crucial it is to encourage students' participation to improve overall mathematical learning achievement.

The regression analysis indicates that the most influential factor that contributes to students' engagement is the affective aspect, followed by behavioral, cognitive and learning approach. Affective aspects such as students' emotions, attitudes, motivation and interest in mathematics are the main factors that lead to student's engagement in mathematics. Students are far more likely to participate actively if they find maths enjoyable, feel secure and have faith in their own abilities. Yet a student who can participate will do so much less because of math anxiety, fear of failure or a negative attitude. A nice emotional quality can engender persistence, curiosity and a willingness to overcome challenges. Hence, emotional factors influence students' engagement in mathematics as well as their motivation and willingness to persevere through challenges. The behavioral component also has a significant impact, indicating that engagement is mostly dependent on observable learning characteristics including involvement, effort, perseverance and task completion. These results demonstrate that student engagement is heavily influenced by their attitudes toward learning and their level of participation in educational events, rather than just their comprehension of the material. The cognitive factor also contributes significantly to engagement, though to a lesser extent than affective and behavioral components. This suggests that while students' use of learning strategies, thought processes and attempts to comprehend topics in a meaningful way are still important, they work best when combined with pleasant feelings and active engagement. The learning approach shows the smallest yet significant effect, suggesting that while learning-related practices and strategies support engagement, their influence may be more indirect or mediated through other factors like affect and behavior.

In conclusion, the correlation analysis revealed significant positive correlations between student engagement in mathematics and all examined variables with behavioral engagement showing the strongest bivariate correlation. However, the regression analysis indicated that the affective aspect emerged as the strongest unique predictor of engagement, followed by behavioral and cognitive aspects, while the learning approach showed the weakest predictive influence. The discrepancy between the correlation and regression findings suggests the presence of shared variance among the engagement dimensions. Although behavioral engagement is strongly associated with engagement at the bivariate level, its unique contribution diminishes when affective and cognitive factors are considered simultaneously. This highlights the central role of affective factors such as students' emotions, attitudes, and motivation in sustaining engagement beyond observable behaviors.

Given the strong influence of affective and behavioral components, researchers could investigate the mediating or moderating roles of affective and behavioral components in the interaction between cognitive aspects, learning practices and engagement to gain a better understanding of how these dimensions interact. Furthermore, to ascertain whether the relative significance of affective, behavioral, cognitive and learning aspects vary across contexts, future study may compare various subject areas or educational levels. Future research may also consider conducting hierarchical regression analyses by including demographic variables such as gender or

academic program as control variables in the initial step, to examine whether the observed relationships remain robust after accounting for these factors.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to all Semester 1 students of UiTM Cawangan Terengganu enrolled in the Business Mathematics course for their valuable support and cooperation during the data collection process. Appreciation is also extended to UiTM Cawangan Terengganu for providing the opportunity and moral support that contributed to the successful publication of this paper.

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