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Factors Affecting Students' Achievement in Mathematics: Case Study in Terengganu

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ABSTRACT

Most programs at the university level require completion of mathematics courses. To survive in university, those who are taking mathematics courses should succeed in their examination so that this can be a path for them to proceed smoothly in their study. This research investigates the factors contributing towards achievement in mathematics at a public university. The identified factors are students' attitude, student-centered learning and classroom environments. The data was collected randomly from 86 students who took business mathematics course in 2018 through a distribution of questionnaires. This study focused on the measurement model and structural model of Partial Least Square analysis. The findings indicate that students' attitude most significantly affected the achievement in mathematics, followed by students' centered learning. Meanwhile, classroom environment is found as an insignificant factor of the achievement in mathematics. As a conclusion, students' attitude is the most influential factor in mathematics achievement compared to students' centered learning and classroom environments. Therefore, the management of higher education should focus on the empowerment of students' attitude towards mathematics subject and improve the quality of student-centered learning at the university.

Keywords: *achievement in mathematics, students' attitude, student-centered learning, classroom environments, Partial Least Square*

INTRODUCTION

It is a fact that mathematics is the foundation of science and technology. The role of mathematics to science and technology is multifaceted and multifarious that no area of science and technology escapes its application (Okereke, 2006). Despite the advancement of the teaching and learning strategies today, students' achievement in mathematics remains low. The result of the 2015 Programme for International Student Assessment (PISA) found that Malaysia ranked as 52nd out of 76 participating international countries. This program is a worldwide study conducted by the Organization for Economic Cooperation and Development (OECD) of 15-year-old students' scholastic performance on mathematics, science and reading.

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In addition, Trends International Mathematics and Science (TIMSS) study in 2015 has shown that even though Malaysian students' performance in mathematics has significantly improved from 440 points in 2011 to 465 in 2015, but it was far behind to compete with top countries like Singapore who ranked 1st place with 621 points in 2015. It implies that the educational system in our country has a problem in different aspects especially in mathematics education. TIMSS is an international bench-marking study conducted by the International Association for the Evaluation of Educational Achievement (IEA).
At the tertiary level, it is important for students to have a strong foundation in mathematics as a prerequisite for admission into tertiary institutions. Students are required to pass this subject in university, in order to avoid any obstacles in their study. At the same time, students' achievement in mathematics needs to be given particular attention at the university level to produce high quality graduates (Davadas & Lay, 2017). In realizing that the achievement in mathematics is a major concern to ensure the students' performance in university, this study intends to investigate the factors contributing towards achievements in mathematics. Identified factors of mathematics achievements are students' attitude, student-centered learning and classroom environments.

LITERATURE REVIEW

Mathematics achievement

Mathematical achievement is the competency shown by the student in mathematics. It is the result of acquired knowledge, understanding, skills and techniques developed in mathematics at a particular stage. Its measure is the score on the achievement test in mathematics (Pandey, 2017). Mathematics achievement during the university years may be some of the critical achievements in a student's academic life. There are many studies that revealed the contribution factors towards mathematics achievement. Among these factors, a positive relationship was often observed between mathematics achievement and students' attitudes towards mathematics (Papanastasiou, 2000). Kiray, Gok & Bozkir (2015) studied the relation between mathematics achievement with the reading skills, problem solving skills, and the influence of cognitive and affective variables among students. By using data mining method, they concluded that science and mathematics achievement is not influenced by the course-specific variable alone but the most important variables are the student's reading and problem-solving skills.

Many researchers have investigated students' achievements in mathematics in various countries. In Malaysia, a few studies have been carried out on such attributions, namely Veloo, Ali, & Krishnasamy (2014); Davadas & Lay (2017) and Zakaria, Chin & Daud (2010). Previous researchers have established several factors as predictors of students' achievements in various courses, including mathematics, such as students' attitude, student-centered learning and classroom environment.

Students' attitude

Learning is defined as "any relatively permanent change in behaviour that occurs as a result of practice and experience" while attitude is a tendency to determine and direct our behaviour. Behaviour may be positive or negative depending upon our attitudes. Students' learning attitude is an important attribute in determining the achievement of students during their study. Students with positive attitudes are likely to succeed and perform well in mathematics (Mata,Monteiro & Peixoto, 2012; Moenikia & Zahed-Babelan, 2010; Singh & Imam, 2013).

According to Eshun (2004), an attitude towards mathematics is defined as "a disposition towards an aspect of mathematics that has been acquired by an individual through his or her beliefs and experiences, but which could be changed". A positive attitude towards mathematics reflects a positive emotional disposition in relation to the subject and, in a similar way, a negative attitude towards mathematics relates to a negative emotional disposition (Zan & Martino, 2008). These emotional dispositions have an impact on an individual's behaviour, as one is likely to do better in a subject that one enjoys, has confidence in or finds useful.

Student-centered learning

Student-centered learning is promoted to improve the students' responsibility on their own learning, which will inspire their passion and achieved a better result (Chen & Yin, 2011). Appropriate learning skill is essential in ensuring students' success in mathematics courses. In a study carried out by Zakaria, Chin & Daud (2010), student-centered approaches such as cooperative learning improve mathematics achievement and attitudes towards mathematics among students and thus changing the practice of teacher-centered teaching methods to student-centered teaching methods is important. A study conducted by Ganyaupfu (2013) indicated that combining both teacher-centered and student-centered teaching methods is the most effective approach that produces best student results. He also found that, student-centered teaching method is an effective teaching approach rather than teacher-centered method which produced lower significant results.

Classroom environments

Suleman and Hussain (2014) reported that studies on the classroom environment revealed that physical environment plays a vital role in the teaching-learning process. A lot of studies have been done on how classroom environments have the influence on the success or failure of students in universities. Turano (2005) identified four factors of classroom environment namely physical environment, time and instructional management, behavior management, and teacher effectiveness. The classroom environment includes many different features. The environment can include the placement of tables and chairs, lighting and temperature, classroom management, discipline techniques, and engaging lesson plans (Suleman and Hussain, 2014). Altamimi (2017) stated that students' performance is related to physical location and facilities, general attractiveness of the facilities, ventilation of the classrooms, lighting and colors of the learning environment.

Some researchers suggested the physical classroom environment had a positive influence on student achievement. McDaniels (2012) stated that a well-designed and organised classroom could help to improve morale and success of the student. According to Fiske et al. (2014), inadequate lighting, noise, low air quality, and lack of heating in the classroom are significantly related to unsatisfactory student achievement. However, the study done by Tosto et al. (2016) found that the classroom environment has no significant influence in students' achievement in mathematics once intrapersonal factors (math interest and academic self-concept) were considered in their study.

Conceptual Framework

As we have reviewed the underlying theory for each model's construct students' attitude, students' centered learning and classroom environments and the achievement in mathematics, we have developed each construct, discussed the relationship and listed the associated hypothesis, as shown below:

H_1: Students' attitude has a significant and positive effect on the students' achievement in mathematics.
H_2: Students' centered learning has a significant and positive effect the students' achievement in mathematics.
H_3: Classroom environments has a significant and positive effect the students' achievement in mathematics.

The conceptual framework for this study is derived from Davadas and Lay (2017) and supported with the theoretical framework which identifies factors related to students' achievement in mathematics. Students' attitude, student-centered learning and classroom environments are presumed to be directly related to achievement in mathematics. Figure 1 shows the conceptual framework which represents the proposed model for this study.

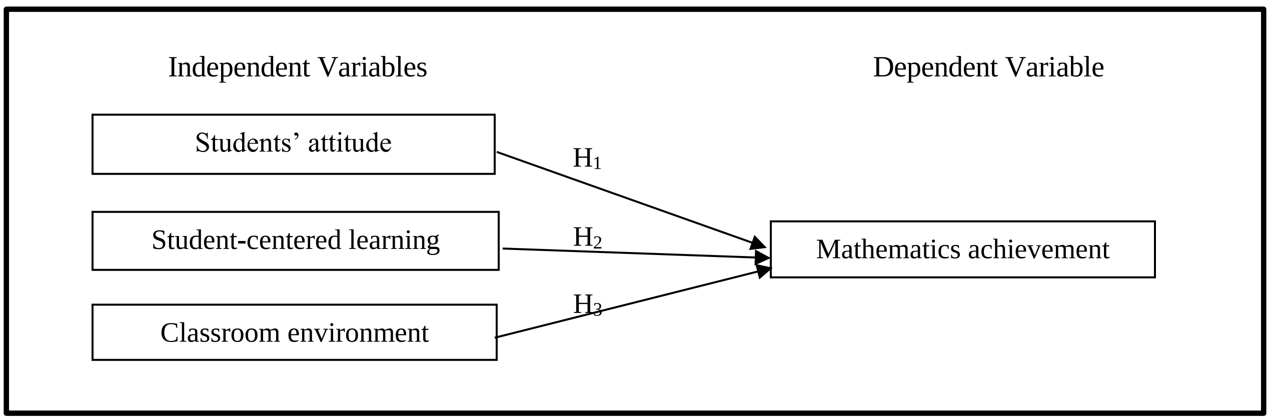

Figure 1: Conceptual framework

METHODOLOGY

The population for this study comprised of all students who took Business Mathematics in 2018 at a public university in Terengganu. Eighty-six (86) students were selected at random as a sample based on the recommendation from Krejcie & Morgan (1970) and Sekaran & Bougie (2016). Questionnaires were randomly distributed to the selected students during their common test in class. The questionnaire was adapted from three existing scales: Students' attitude (Tahar, 2010), Student-centered learning (Tessema, 2010) and Classroom environment (Shamaki, 2015).
There are 5 sections in the questionnaire. Section A covers the demographic profile. Section B addresses the factors of students' attitude; section C on the factors of student-centered learning style and section D focuses on factors of the classroom environment. All items in section B, C and D used the Likert scale with five options. Meanwhile section E consists of the information on students' achievement regarding their continuous assessment and final examination marks for the subject.

The data were analysed using the Smart Partial Least Square (PLS) software. For the analysis, the validity and reliability of the measurement model were implemented to ensure all the indicators represent its construct. Then the data was analysed to test the relationship between the indicator and their corresponding construct (measurement model) and the relationship between constructs (structural model).

RESULT AND FINDING

At the measurement model level, PLS estimates items loading and residual covariance. It is also important to evaluate the convergence and discriminant validity by checking the value of composite reliability and average variance extracted (Fornel, 1982). The next step is to check the relationships between constructs that were hypothesised in the conceptual framework at the structural model level. At this level, PLS estimates path coefficient and correlation among the construct, together with the coefficient of determination (R-squares).

The measurement model

Table 1: Assessment of the measurement model

Variable construct	The composite reliability	Cronbach's Alpha	Average variance extracted/explained
Mathematics achievement	0.982	0.988	0.966
Students' attitude	0.892	0.914	0.571
Student-centered learning	0.749	0.832	0.499
Classroom environment	0.732	0.806	0.455

Table 1 shows that the assessment result of the measurement model. All the composite reliabilities and Cronbach's alphas for the entire construct are greater than 0.70, which demonstrates that it is adequate (Nunally, 1994 and Churchill, 1979). The value of variance extracted for achievement in mathematics and students' attitude were above the recommended value of 0.5 as suggested by Hair et al (2016). Although the AVE value for another two constructs were less than 0.5 (student-centered learning and classroom environments), but the value of 0.4 is still acceptable. According to Fornell & Larcker (1981), if AVE is less than 0.5, but the composite reliability is higher than 0.6, then the convergent validity of the construct is still adequate. These results confirmed the convergent validity and satisfactory internal consistency of the measurement model.

Table 2: Discriminant validity (intercorrelation) of variable constructs

Variable construct	Mathematics achievement	Students' attitude	Student-centered learning	Classroom environment
Mathematics achievement	**0.983**			
Students' attitude	0.590	**0.756**		
Student-centered learning	0.449	0.123	**0.706**	
Classroom environment	0.286	0.081	0.390	**0.675**

Table 2 compares the square root of the average variance extracted (AVE) with the correlations among reflective construct. The values in matrix diagonal are greater in all cases than the off-diagonal values in their corresponding row and column implying satisfactory discriminant validity.

Table 3: Factor loading and cross loadings

Indicator	Mathematics achievement	Students' attitude	Student-centered learning	Classroom environment
ACH1	**0.972**	0.593	0.482	0.280
ACH2	**0.977**	0.559	0.398	0.278
ACH3	**0.999**	0.585	0.440	0.285
ATT2	0.475	**0.788**	0.095	0.130
ATT3	0.400	**0.674**	0.179	0.230
ATT4	0.438	**0.730**	0.050	0.069
ATT5	0.492	**0.855**	0.103	0.052
ATT6	0.495	**0.764**	0.084	0.051
ATT7	0.354	**0.734**	0.024	-0.086
ATT8	0.489	**0.773**	0.151	0.056
ATT9	0.387	**0.716**	0.043	-0.043
SCL3	0.246	0.027	**0.633**	0.350
SCL6	0.309	-0.050	**0.702**	0.310
SCL7	0.314	0.146	**0.745**	0.221
SCL8	0.338	0.113	**0.696**	0.299
SCL9	0.362	0.170	**0.748**	0.227
ENV1	0.183	0.163	0.170	**0.745**
ENV10	0.078	-0.029	0.341	**0.600**
ENV6	0.284	0.097	0.298	**0.694**
ENV8	0.142	0.069	0.242	**0.608**
ENV9	0.159	-0.114	0.313	**0.712**

We also tested the convergent validity by examining the factors and cross loading all indicator items with their respective constructs. Table 3 displays that all indicator loaded on their respective from 0.600 to 0.999 while all the cross loading with other constructs are considerably lower than the provided acceptable validation for the discriminant validity of the measurement model. As a result, the suggested conceptual model is considered to be acceptable, with the confirmation of adequate reliability, convergent validity, and discriminant validity and the verification of the model.

The structural model

The structural model represents the relationships between the constructs that were hypothesized in the conceptual model (Figure 1). The coefficient of determination measures the overall effect size and variance explained in the endogenous construct and thus a measure of the model's predictive accuracy. The coefficient of determination also can be interpreted in the same way as regression analysis. The high value of R2 indicate that the value of the construct can be well predicted through the PLS path model (Hair et al, 2016). The path coefficient (β) is the expected variation in the dependent construct for a unit variation in the independent construct(s) (Chin, 1998).

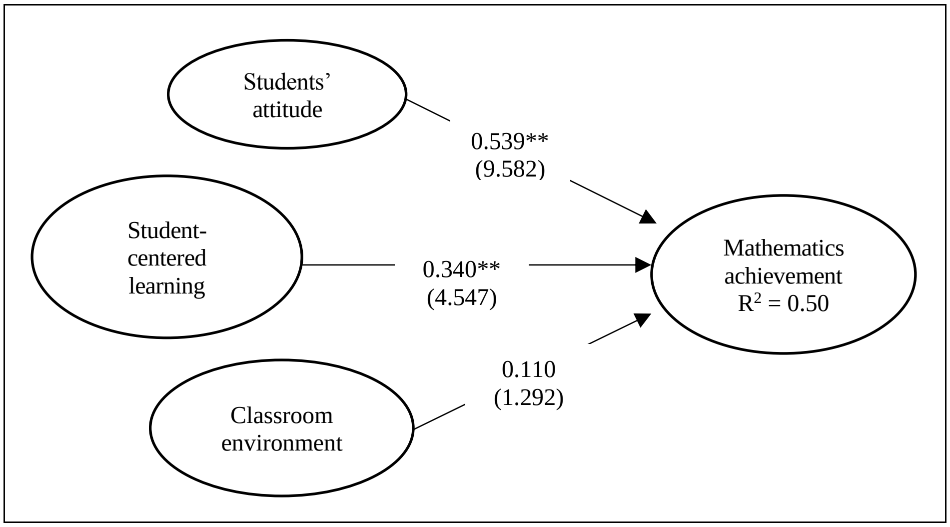

Figure 2: Result of Structural Model with path coefficient (associated t-statistics are in the parenthesis). *Indicates significance at 0.05 level. **Indicates the significance at 0.01 level.

Figure 2 shows the result of structural model with path coefficient, t statistics and R2. The analysis revealed that this model explained 50% of the variation in students' achievement in mathematics, suggesting that this model provided moderate explanatory power. The path between students' attitude and achievement in mathematics was highly significant (beta=0.539, t value=9.582). It means that hypothesis 1 is supported thus can be considered as a construct that strongly affects students' achievement in mathematics. The path between student-centered learning and achievement in mathematics was moderately significant (beta=0.340, t value=4.547) therefore indicating a positive relationship. The path between classroom environments and achievement in mathematics was found to be insignificant (beta= 0.110, t value=1.292) indicating that classroom environment was not the factor affecting the achievement in mathematics. As a conclusion, this model is an adequate model since all the criteria are met.

DISCUSSION

Table 4 presents the hypotheses, relationship between the constructs, the path coefficient, t value and outcomes. The last column indicates whether the hypothesis was supported or not supported. The result suggests that only two hypotheses were supported since the relationship are significant. The study found that students' attitude had a strong positive effect while student-centered learning had a moderate positive effect on the achievement in mathematics. This indicates that, the achievements in mathematics are more successful if the students have a positive attitude in learning as mentioned by Singh & Imam (2013). As for student-centered learning, students will achieve a higher achievement marks if the students are aware and take responsibility of their own learning. Meanwhile, classroom environment was found to have no effect on the achievement in mathematics.

Table 4: Structural result

Hypotheses	Relationship	Path coefficient	t-value	P-value	Outcomes
H_1	Students' attitude -> Mathematics achievement	0.539	9.582	0.000	Supported
H_2	Student-centered learning -> Mathematics achievement	0.340	4.547	0.000	Supported
H_3	Classroom environment -> Mathematics achievement	0.110	1.292	0.197	Not supported

CONCLUSION

This paper aims to identify the association between students' achievement in mathematics based on students' attitude, student-centered learning and classroom environments. As students' attitude play an important role in mathematics achievement, efforts should be made by the management of the university to cultivate the students' interest and commitment in learning mathematics. These may include developing a module on learning techniques and introducing a new flexible teaching method to attract students. Students also need to have the desire to change by instilling a sense of responsibility towards themselves. For student-centered learning, such learning methods need to be expanded at university level. The management of the university can help to encourage the lecturers and students to use this method by introducing a standard student-centered learning module for mathematics subject and provide all the necessary tools and facilities needed. Even though classroom environments are not significant in this study, it should be noted as well. As the service provider, the university should provide the best and conducive class environment to the students.

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