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Relationship Between Learning Environment and Secondary School Students' Mathematics Achievement

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Abstract: Studies concerning mathematics achievement indicated that the achievement status of Malaysia students is in alarming condition, especially among secondary school students. Ineffective learning environment has been identified as among the factors that led to such problem. Bransford, Brown and Cocking [1] built a holistic learning environment model that consists of four components, namely learner-centered learning environment, knowledge-centered learning environment, assessment-centered learning environment and community-centered learning environment. This study aims to identify the relationship between those learning environment components and secondary school students' mathematics achievement. This study involved a total of 333 Form Four students from ten secondary schools located in one of the states in Malaysia who were selected by using multistage stratified random sampling. The obtained data have been analyzed by using Structural Equation Modeling (SEM) technique. The results showed that assessment-centered learning environment component had positive, significant relationship toward secondary school students' mathematics achievement, while other learning environment components (learner-centered, knowledge-centered and community-centered) did not have significant relationship toward secondary school students' mathematics achievement. Educational implications of this study in regard to the teaching and learning of mathematics were discussed.

Key words: Learning environment · Mathematics achievement · Bransford · Brown and Cocking [1] Learning Environment Model · Structural Equation Modeling (SEM)

INTRODUCTION

Mathematics is a very desirable tool in virtually all spheres of human endeavor since its use pervades all facets of human life [2-7]. In a particular developing country, mathematics plays crucial role in terms of economic development by influencing governmental and corporate decision making [2, 3, 8, 9]. Besides being a necessity for many careers [3, 6, 7, 11, 12], mathematical knowledge also serves a gatekeeping function for academic achievement and high school graduation. In terms of personality, mathematical knowledge affects one's personal development by encouraging the habit of self-reliance and improving one's problem solving abilities [3, 4, 8]. Due to the awareness regarding the negative effects that will be faced by students if they do not possess mathematical knowledge and skills, mathematics has been selected as among the subjects that must be mastered by students in most educational systems around the world [4, 10, 13-16].

In spite of the stated importance of mathematics, evidence abound that Malaysian students' performance and achievement in this subject was andis still in alarming condition. This problem is identified by considering the status of Malaysian students' achievement as reported by Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA). Trends in International Mathematics and Science Study (TIMSS), yielded that Malaysia's ranking has dropped from 10th place out of 45 countries to 20th place out of 49 countries in the assessment conducted in 2007, while the assessment carried out in

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2011 revealed that Malaysia's ranking has dropped to the 26th place out of 42 countries worldwide. Program for International Student Assessment (PISA) showed that Malaysia was ranked 57th out of 74 countries involved in the assessment that has been conducted in 2009. Those reports implies the failure of Malaysian students in reaching the minimum level required in enabling them to participate in life effectively and productively.

Literature is replete with evidence to show that learning environment has the potential of influencing students' mathematics achievement [17-22]. The new reform in mathematics education emphasizes the need for creating collaborative and learner-centered learning environments. However, mathematics teachers were found to be continually practicing traditional approach, especially in secondary schools [23]. They preferred to use lecturing as their primary teaching method [24, 25] and emphasize summative rather than formative assessment. These practices led to poor students' participationwhich eventually resulted in low student achievement.

Changes in educational goals require rethinking about what is taught, how teachers teach and how what students learn is assessed. Based on key findings of research on learning, Bransford, Brown and Cocking [1] introduced a holistic learning environment model which comprises of four components, namely learner-centered, knowledge-centered, assessment-centered and community-centered. Such components were believed to mutually support each other in optimizing students' learning.

Learner-Centered Environment: Learner-centered environment refers to the learning environment that emphasizes on the importance of attending to the knowledge, skills, attitudes and beliefs that students bring into the classroom context. Besides, it also entails the importance of integrating students' cultural background into the teaching and learning process and a sense of respect to the students' language practices. Learner-centered environments expose students with a meaningful learning experience by encouraging students to connect their existing knowledge, skills, attitudes and beliefs with what is being taught [26, 27]. In educational context, learner-centered environment stresses on the importance of drawing out students' preconceptions as they serve as a basis to a more formal understanding of what is being learnt [28]. In this regard, teachers are required to cultivate authentic learning by creating a link between what is learnt in the classroom with students' real experience [26, 27]. Besides, various learner-centered approaches can also be practiced by teachers in order to provide such environment which include responsive teaching [29, 30] and diagnostic teaching [31].

Knowledge-Centered Environment: Knowledge-centered environment refers to learning environments that helps students to become knowledgeable by emphasizing on learning with understanding [32-34] and subsequent transfer [35]. Learning with understanding involves students' ability to organize their knowledge meaningfully [36], while transfer entails students' ability to apply their knowledge in various contexts [37]. In order to encourage learning with understanding and learning transfer, knowledge-centered environment focuses on the information and activities that arebelieved to help students develop an in-depth and integrated understanding of a particular discipline. Besides, it also requires major concepts to be taught in multiple contexts so that learning can be transferred from one context to the other [15]. In addition, knowledge-centered environment also emphasizes on sense-making through metacognitive approaches [36-41] that can help student to become metacognitive experts who can regulate their ownlearning.

Assessment-Centered Environment: Assessment-centered environmental refers to learning environments that emphasizes the importance of continuous feedback in helping students to improve their learning [42]. Assessment-centered environment requires that assessments, either in the form of formative or summative, designed to assess students' understanding, provide opportunities for students to enhance their learning [43]. In this model, greater emphasis is given to formative types of assessment since they can provide information about students' level of understanding continuously. Apart from that, assessment-centered environment also stresses the importance of helping students in developing self-assessment skills so that students can become more responsible to their own learning [44]. The provision of assessment-centered learning environment marks a major shift of traditional belief that mathematics are about memorization of formulae. It requires teachers to give continuous feedback to students that should not only be on time, specific and understandable, but also provide room for students' improvement [33]. Other than that, it

also requires teachers to conduct various types of assessments in order to obtain a more accurate information about students' level of understanding.

Community-Centered Environment: Community-centered environment refers to learning environment that emphasizes the importance of establishing positive norms among members of the learning community in order to improve students' learning [45]. Such norms include cultures to learn from each other which can be achieved through cooperative learning approaches [46, 47]. Besides, it also gives freedom for teachers and students to make mistakes in order to learn [48] and positive relationships among classroom, school and the broader community [49, 50]. According to this model, learning community should be established both inside and outside school setting. Learning community inside the school setting can be established by encouraging collaboration among classroom and school community members [46, 47], while the establishment of learning community outside school setting can be achieved by connecting between what is being learnt in schools and the learning experience encountered by students when they are not in schools, such as after-school programs and home environment [49, 50]. The establishment of learning community is believed to be crucial in improving students' achievement through the collaboration among its members in achieving common learning goals [22]. The provision of community-centered environments requires teachers to encourage student interaction through which students can build in-depth understanding which eventually lead to the improvement in their achievement. In other words, students should be given the opportunity to participate in classroom discussions and to negotiate ideas and understandings with peers in order to optimize their mathematics learning.

Learning environment model introduced by Bransford, Brown and Cocking [1] seeks to ensure that students are exposed to a holistic learning environment by catering various aspects that are believed to influence students intellectual development, which include psychological, emotional, social and cultural [51]. Reviews of the literature have confirmed the importance of inculcating the characteristics of learner-centered, knowledge-centered, assessment-centered and community-centered learning environments in improving middle students' achievement [17-22, 40, 52]. However, little is known about learning environment component(s) that has significant role in influencing middle students' mathematics achievement. Hence, this study was conducted to identify the relationship between learning environment components and secondary school students' mathematics achievement. Specifically, the research question that would be answered through this study was: Which learning environment component(s) has significant relationship with secondary school students' mathematics achievement?

MATERIALS AND METHOD

A total of 333 secondary schools students from ten secondary schools located in one of the state in Malaysia had been selected by using multistage stratified random sampling technique to participate in this study. Two instruments were used for the purpose of data collection in this study:

Learning Environment: Learning environment was measured by using a questionnaire developed by the researcher which consists of 24 items related to foru learning environment components as suggested by Bransford, Brown and Cocking's [1] learning environment model, namely learner-centered, knowledge-centered, assessment-centered and community-centered. Respondents were asked to indicate the learning environment that they experience in mathematics classroom by responding to the questionnaire items using a 5-level Likertscale ranging from strongly disagree to strongly agree. Results of factor analytical analyses had been used to determine the validity and reliability of this instrument. Exploratory factor analysis (EFA) extracted four factors which were in line to the four learning environment components, while confirmatory factor analysis (CFA) revealed that the obtained Average Variance Extracted (AVE) and construct reliability (c.r) were 0.555 and 0.830, respectively. Elimination of several items based on the factor analytical analyses led to the inclusion of 12 items in the final analysis, whereby three items have been identified to represent each learning environment component.

Mathematics Achievement: Mathematics achievement was measured by the students' scores in three types of assessment, which were final year examination, monthly test and Program for International Student Assessment (PISA). The scores were provided by the school

management and had been standardized in order to ensure their uniformity. The obtained data were analyzed using Structural Equation Modeling (SEM) techniques through Analysis of Moment Structure (AMOS) software to determine the relationship between learning environment components and secondary school students' mathematics achievement. In this regard, Confirmatory Factor Analysis (CFA) was employed in order to test the fitness of the proposed relationship as well as to examine the significance of the relationship between problem learning environment components and mathematics achievement.

RESULTS

Results of confirmatory factor (CFA) analysis showed that the obtained chi-square value (x^2) = 152.150 with degrees of freedom df = 80 at the significant level of p <0.001. The obtained fitness index values for the model indicated that the structural model analyzed corresponds to the data obtained in this study (normed chi-square, (x^2/df) = 1.902, Comparative Fit Index (CFI) = 0.970, Root Mean Square Error of Approximation, RMSEA = 0.052). The obtained value of coefficient determination (R^2) is 0.30, which indicated that learning environment contributed to 30% of the variance in secondary school students' mathematics achievement. The results of the analysis are shown in Figure 1.

The relationship between the components of learning environment and mathematics achievement is determined by considering the obtained value of path coefficient (β), critical region (t) and the probability (p) for each component. First, analysis of the relationship between learner-centered learning environment component and mathematics achievement indicated that learner-centered learning environment has no significant relationship with mathematics achievement (β = 0.097, t = 0.549 and p = 0.583). Second, analysis of the relationship between knowledge-centered learning environment component and mathematics achievement indicated that knowledge-centered learning environment has no significant relationship with mathematics achievement (β = 0.035, t = 0.191 and p = 0.848). Third, analysis of the relationship between assessment-centered learning environment component and mathematics achievement indicated that assessment-centered learning environment has significant relationship with mathematics achievement at p<0.1 (β = 0.352, t = 1.657 and p = 0.097). Fourth, analysis of the relationship between community-centered learning environment component and mathematics achievement indicated that community-centered learning environment has no significant relationship with mathematics achievement (β = 0.105, t = 0.543 and p = 0.587).

The results of the relationship between each learning environment component and mathematics achievement are shown in Table 1.

Table 1: Relationship between Learning Environment Components and Mathematics' Achievement

Relationship	β	t	p
Learner-centered Environment and Achievement	0.097	0.549	0.583
Knowledge-centered Environment and Achievement	0.035	0.191	0.848
Assessment-centered Environment and Achievement	0.352	1.657	0.097
Community-centered Environment and Achievement	0.105	0.543	0.587

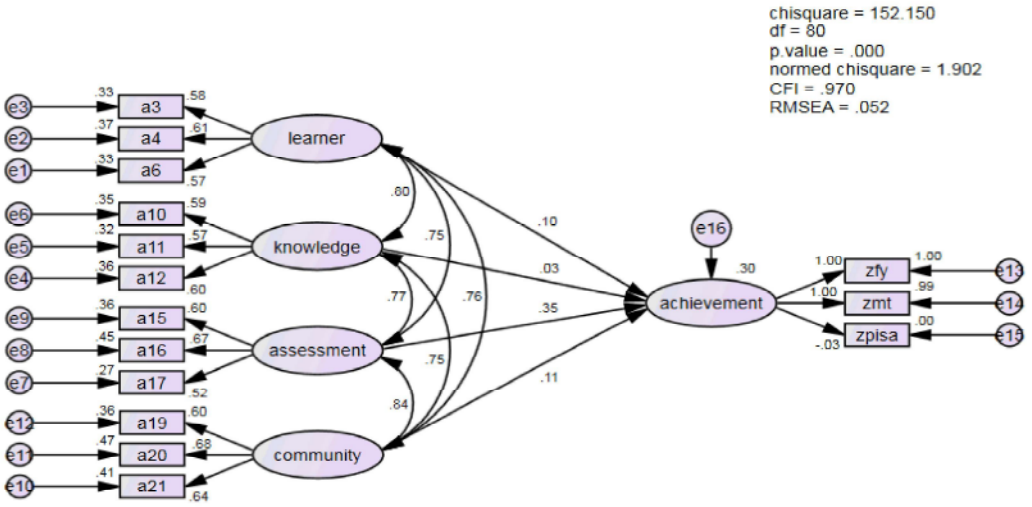

Fig. 1: Relationship between Learning Environment Components and Mathematics Achievement

DISCUSSION

Findings of this study revealed that assessment-centered learning environment component has a significantrelationship with secondary school mathematics achievement, while another three learning environment components (learner-centered, knowledge-centered and community-centered) had no significant relationship with secondary school students' mathematics achievement. These findings can be justified by considering the great emphasis given to the aspect of assessment as the most important medium to reflect the level of mathematics achievement of Malaysian students, whereby the scores of various assessments were used to indicate students' achievement, especially for those in secondary level education. For example, besides Malaysian Certificate of Education (SPM), secondary school students also have to face other mandatory assessments including monthly tests which are conducted in each school term, mid-year examination and final year examination. Such assessments indirectly influence student to develop the tendency to become 'exam-oriented', a term which refers to students who give priority to the scores obtained in the assessments carried out on them.

The findings of this study have several important educational implications, especially in secondary school context. Based on the findings, it is clear that assessment-centered learning environment plays important role in improving secondary school students' mathematics achievement. Therefore, attention should be given to the inculcation of the assessment-centered characteristics in order to improve students' mathematics achievement. This can be done by providing continuous feedback to students, conducting formative types of assessments, encouraging the development of self-assessment skills among students and assessing students' higher order thinking skills. Apart from that, this study also indicated that mathematic educators should rethink about the effectiveness of their current teaching method in improving students' learning. This is due to the findings of this study that indicated the insignificant relationship between three learning environment components (learner-centered, knowledge-centered and community-centered) and mathematics achievement. Based on this finding, mathematics teachers are recommended to pay attention to the lack of inculcation of learner-centered, knowledge-centered and community-centered characteristics in their classroom and take appropriate actions as a way to provide a more holistic learning environment in order to improve students' learning, especially in mathematics.

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