

THE EFFECTIVENESS OF SM-AEROMECH FOR ENHANCING STUDENT'S ACHIEVEMENT IN MATHEMATICS

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Abstract

The aim of this research is to find the effectiveness of Circular Measure Aero Physics and Mechanic (SM-AEROMECH) module and conventional approach in students' achievement for circular measure topic in mathematics. The students' achievement in circular measure topic is compared by gender and the interaction effect between groups and gender was studied. The instrument used in this research is Circular Measure Test (CMT). A quasi-experimental research design with non-equivalent control group pre-test and post-test was used. The participants of this research are Malaysian upper secondary four science stream students. This research involved a total of 64 students, 31 of whom were males and 33 were females. The two-way ANOVA analysis showed that the effectiveness of group on the post CMT mean score was not significant. It concluded that the level of students' achievement for circular measure topic is same in SM-AEROMECH module or conventional approach. Hence, the achievement in circular measure topic on gender is not significant. Male and female students' achievement in circular measure topic is the same. The analysis also showed that the interaction effect between group and gender is not significant either as the mean group's influence on the mean score CMT is not caused by the gender and vice versa.

Keywords : Circular Measure, SM-AEROMECH module, Conventional approach,

Gender

Introduction

Mathematics subject has the interests and consumerism considered by the students as a difficult, tedious, impractical and abstract subject. To learn mathematics, students required special mental abilities that students find difficult to make (Ignacio, Nieto, & Barona, 2006). Most of the studies show that one of the reason for the failure of students in mathematics is the weakness of students to apply the mathematical concepts learned formally due to the abstraction of student conception during the learning (Ramirez, Chang, Maloney, Levine, & Beilock, 2016). Many students have negative attitudes towards mathematical applications in daily life. For them, mathematical learning is not for life satisfaction, but mathematical learning causes them frustration, anxiety, depression and boring activity (Ignacio et al., 2006; Zakaria, Zain, Ahmad, & Erlina, 2012)Malaysia. The research examined the differences in mathematics anxiety according to gender as well as the differences in mathematics achievement of students based on the level of mathematics anxiety. The study involved 195 Form Four students (86 male and 109 female).

The Ministry of Education Malaysia (MOE), through the Standard Secondary School Curriculum (SSSC) has further strengthened the interdisciplinary approach of Science, Technology, Engineering, and Mathematics

(STEM) in computer-based and information-based teaching methods. These new methods are able to replace conventional teaching methods in various ways to improve the learning. In order to realize the information and communication technology (ICT) and multimedia technology in the education, MOE has been working on advancing the education system by applying information technology elements across the curriculum. The rapid development and reformation of mathematical education today is a challenge for us to discuss about it. Thus, implementation of a new strategy can help the mathematical curriculum continue to survive and adapt in the 21st century education system.

A knowledgeable and highly educated society in mathematics needs to address the challenges of everyday life in realizing the country's aspirations to become an advanced nation in science and technology (Siti Mistima & Effandi, 2010). Pupils are nurtured early in pre-school and primary school with problem solving skills and communicate mathematically using computer technology to enable them to make effective decisions at a higher level (Sharifah Nor & Kamarul Azman, 2011). Mathematics is important in providing a workforce capable of meeting the needs of employment in a progressive country. As such, this field takes a role as a driving force for various developments in science and technology. The transformation of SSSC and the standard primary school curriculum (SPSC) in the Malaysian Education Blueprint (2013-2025) are an enhancement of the existing curriculum to provide students with the knowledge, skills of ICT relevant to current needs and challenges (Preliminary Report & MEB, 2013). In this regard, transformation of the curriculum in using ICT should be able to support the effort of providing creative, innovative, computer literate skills, high competence, creativity, computer literacy innovation that meets the needs of the 21st century economic market so that the human being will be positive, pure noble valued and will help in growing people's lives (Nurul Nashrah, Noor Hasimah, & Nur Aida, 2015).

The 21st century education curriculum focuses on the use of ICT in teaching and learning so that students are more literate and able to learn in a more enjoyable way. For that purpose, the SM-AEROMECH interactive module designed based on multimedia is desirable so that students are not left behind in the engineering world, especially mechanics and aero physics. This module is developed for learning based on ICT through multimedia using various theories of learning and software theory.

SM-AEROMECH Interactive module

The SM-AEROMECH interactive module is using multimedia approach based on three main theories, namely the theory of behaviourism, cognitivism and constructivism. The three main theories are the basis for modular pedagogy and can increase the attention of students to learn. The use of pedagogical based modules can vary and stimulate student learning levels (Nurul Nashrah et al., 2015). Combination of the three theories can leverage the teachers in diversifying the delivery method, especially students who are less interested and put less effort.

SM-AEROMECH interactive module is a multimedia-based module. This module is built on proper multimedia theory. For this study, the SM-AEROMECH interactive module was developed based on Multimedia Learning Cognitive Theory (CTML). There are some important information and principles in CTML included in the SM-AEROMECH module. Information in form of diagram and text are used in this module. This information will help students to focus on the effects and divisions. Students can focus on information as it is received from the diagram and text simultaneously. Information in multimedia learning materials can be delivered in two or more ways using diagrams and texts for example (Mayer, 1997). Effective multimedia presentation planning will be possible if the presentation designer understands the way students combine words and diagrams mentally (Mayer & Moreno, 1998). This process has been done in the SM-

AEROMECH interactive module built through animations and simulations that co-exist with the texts and diagrams during the learning of circular measure topic in mathematics.

The researcher developed the SM-AEROMECH interactive module based on the design and development of Dick & Carey (Revised 1996) instructional model which followed the needs and conditions of learning AM at school (Dick & Carey, 1996). The main components in this study will be evaluated on the Form Four students' achievement in the topic of the circular measure. This model basically involves 10 steps.

Figure 1 show the steps involve in Dick & Carey instructional model.

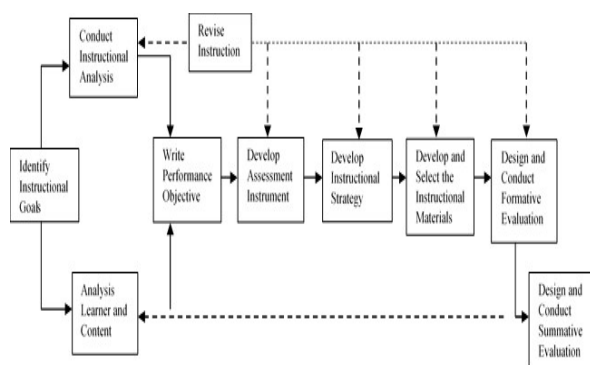


Figure 1 Dick & Carey Instructional Model (Revised 1996)

This model allows users to move forward and back independently linear. The Dick & Carey model is also an active pro learning process because the previous step is an input to the next step. Dick & Carey models are suitable to develop SM-AEROMECH interactive modules for circular measure topic in mathematics.

METHODOLOGY

Research Design

This research uses quasi-experimental design to compare the effectiveness of SM-AEROMECH instructional module (experiment group, EG) and conventional approach (control group, CG) on student achievement towards mathematics

in circular measure topic. This research is also aimed to compare student achievement towards mathematics with students' gender. The type of quasi-experimental design used is a non-equivalent control group pre-test and post-test. The design of this research is shown as in Table 1.

Instrument

The instrument of this research is circular measure pre and post-test (CMT). The test consists 10 objective and 12 subjective items. The objective items were designed to test the conceptual understanding of the circular measure topic and its applications in the field of mechanics and aero physics. Subjective items were developed to test the understanding of the concepts and the calculation procedures for the circular measure as well as its applications in the field of mechanics and aero physics. Circular measure is weight at 40% because circular measure content is the basis of circular concepts in radians to apply at mechanics and aero physics field. While mechanical and aero physics items are weighted 30% each. All items in CMT have been constructed using the Test Specification Table (TST) and suitable with the level of Form Four students. Cognitive domains are compatible with the Malaysian Certificate of Education (MCE) examinations and items validity has been certified by two mathematics teachers and two experienced physics teachers. Reliability test has been performed on all items in CMT using Test-Retest method. It describes the consistent score all the time when it was tested. The same instrument is assessed repeatedly on the same sample group, at different times. Two sets of data obtained be analysed through correlation analysis to see the strength of the relationship. The coefficient reliability for all items are near to 1 and this value indicate that the instrument reliability is high.

Sample

A Rural National Secondary School (NSS)

in Malaysia was selected to take part in this research. Two classes from the same school were selected to engage in real studies. Students from one class were assigned as an experimental group and another class was assigned as a control group. Students from both classes involved in this research are from science stream. Overall, this study involved a total of 64 participants with 31 males and 33 females. Table 2 shows the number of participants involved in this research.

Data Analysis

Data was analysed using descriptive and inference statistic. Descriptive data was discussed by using mean, standard deviation and frequency. While inferential data was discussed by using two-way ANOVA.

Table 1 Research Design

		Circular Measure		
		Treatment		
Class 1	Pre-test	X1	(EG)	Post-test
Class 2	Pre-test	X2	(CG)	Post-test

Table 2 Sample of Research by Group and Gender

Group		Gender		Total
		Male	Female	
Class 1	EG	16	17	33
Class 2	CG	15	16	31
Total		31	33	64

RESULTS

Student achievement is obtained through post-test achievement after an intervention is conducted. The descriptive statistic of post-test by group and gender is shown in Table 3.

Table 3 Descriptive Statistic of CMT Post-test

Group	Gender	M	SD	N
Control	Male	51.80	17.79	15
	Female	44.81	7.65	16
	Total	48.19	13.77	31
Experiment	Male	41.81	7.66	16
	Female	50.12	4.36	17
	Total	46.09	7.40	33
Total	Male	46.64	14.24	31
	Female	47.54	6.65	33
	Total	47.11	10.92	64

Descriptive statistics from Table 3 shows that the post mean score of CG (M = 48.19, SD = 13.77) is higher than EG (M = 46.09, SD = 7.40). Meanwhile for gender, the post mean score of female participants (M = 47.54, SD = 6.65) is higher than the male participants (M = 46.64, SD = 14.24). When compared the post mean score for gender in the control group, it was found that post mean score for male (M = 51.80, SD = 17.79) is higher than female (M = 44.81, SD = 7.65). Meanwhile in EG, post mean score female (M = 50.12, SD = 4.36) is higher than male (M = 41.81, SD = 7.66). Figure 2 shows the comparison of post mean score between group and gender. Based on Figure 2, the mean score gap between male and female in EG is greater than the CG. The mean score difference between male (41.81) and female (50.12) in the EG is 8.31, while the mean score difference between male (51.80) and female (44.81) in CG is 6.99. The difference in mean score between these two groups is relatively small.

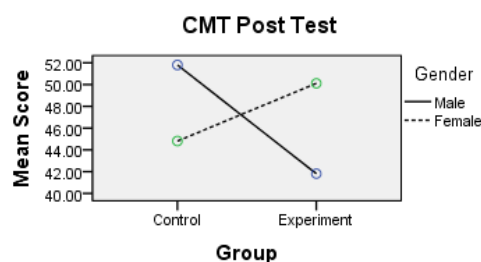


Figure 2 Comparison of Post Mean Score between Group and Gender

Table 4 shows the Two-Way ANOVA analysis of main effects and interaction effects on achievement of students for circular measure topic in mathematics subject. The two main effects of this research are group (EG and CG) and gender (male and female). Table 4 shows that the main effect of group on CMT mean score is not significant, $F(1,63) = 0.809$, $p = 0.067$. Meanwhile the descriptive statistics shows that the post mean score of CG is higher than the EG. These outcomes show that students' achievement in circular measure has not improved with SM-AEROMECH module. This module is less effective than the conventional approach for learning circular measure topic in mathematics. The main effect of gender on CMT mean score also is not significant, $F(1, 63) = 0.064$, $P = 0.710$. Total mean score of female participants is higher than male participants. It can be concluded that the achievement of female participants for circular measure topic is better than male participants. The ANOVA analysis also was used to find the interaction effect between group and gender based on post mean score of CMT. The result shows that the interaction effect between group and gender is not significant also, $F(1, 63) = 8.627$, $P = 0.061$. The groups' influence on post mean score of CMT is not due to gender and the gender influence on post mean score of CMT is not due to groups.

Table 4 Two-way ANOVA Analysis for main effect and interaction effect of Group and Gender

Resources	Sum of squares	df	Mean squares	F	P
Group	87.526	1	87.526	0.809	0.067
Gender	6.931	1	6.931	0.064	0.710
Group*Gender	933.630	1	933.630	8.627	0.061

Significant level = 0.05

Discussion

Effect of group to students' achievement for circular measure topic is not significant but the descriptive analysis shows that the post mean

score for CG is higher than EG. This outcome shows that the SM-AEROMECH module is not helping the additional mathematics students improve their achievements in topic circular measure. Multimedia approach that was used in SM-AEROMECH module did not give any significant different on students achievements. For circular measure topic, students' achievement becomes better if the teacher uses the conventional method in their teaching. The use of conventional approach is a common and routine method in learning mathematics. Students are very comfortable with teacher's personnel approach in teaching mathematic. Teachers mathematical knowledge will support the students achievements in mathematics (Loewenberg, Hill, & Bass, 2005; Hill, Ball, & Schilling, 2008). The content knowledge of the teacher in mathematics will boost students' confidence to learn mathematics and students may not depend on technologies resorting to learn-individually (Nam & Zellner, 2011). Other than the ICT usage, it will also give negative impact to mathematics achievements in long term when students' environment and social economic plummet (Zhang & Liu, 2016).

This research was done in a rural school. The teachers in the rural school had a very strong desire to integrate ICT in their teaching and learning process but they face many problems such as lack of confidence, competence and problem in access to various resources (Bingimlas, 2009). These barriers will incur students losing their confidence in learning using ICT. The research outcomes show the students are not familiar learning using ICT and this will affect their achievements. Teachers need to provide with various ICT resources, continue profesional development, sufficient time and technical support to increase the integration of ICT in teaching and learning process (Bingimlas, 2009). Other than that, teachers prefer to conduct teaching through explanation because teachers' intention is to save time in avoiding students to lose concentration while teaching. Multimedia approach will be successful and effective for teaching and learning of mathematics if the

teacher and students understand of the effects of technology strategies on mathematics teaching and learning (Coley, Cradler, & Engel, 2000; Goos & Bennison, 2008)

In Malaysia, school are provided with computer lab, software and other ICT technologies. Although schools provide many types of technologies, but simply having these technologies do not mean that teachers and students are able to use them whenever appropriate or necessary (Cuban, Kirkpatrick, & Peck, 2001; Wallace, 2004). So, it is a mistake to assume that technologies will help teachers to encourage and motivate them into more innovative teaching approaches. Most teachers complain that lack of time and profesional development about the technologies as a major obstacles (Goos & Bennison, 2008). When teachers are not comfortable to teach using ICT or technologies, it will affect the students' learning too. Students also will face problem learning though ICT or technologies and when we force students to use it, their achievement in the particular subject will regress. Even though many researches found that technology-assisted teaching has attracted and encouraged students fun learning (Lee, Waxman, Wu, Michko, & Lin, 2013; Zwickl, Finkelstein, & Lewandowski, 2012) but it is not necessary that it will help them to improve their achievement because the success in mathematics requires not only knowledge but the right mind set to learn it. Students must be anxious about mathematics and this will help them typically perform at a higher level compare to their normal abilities (Beilock & Maloney, 2015; Ramirez et al., 2016).

SM-AEROMECH module using the multimedia approach will make students to learn calculation procedure in circular measure topic individually. In this research, each student was provided with computer individually and this causes the students to do their module activities individually. When students did the circular measure activities individually, they had passive and less interaction with other students. Even though

individual computers will cause students to involve in all the activities in SM-AEROMECH module and offer greater flexibility for students to adapt better performance according to their abilities (Lou, Abrami, & D'Apollonia, 2001; Taconis, Ferguson-Hessler, & Broekkamp, 2001) which are expected to be more effective. To get an overview of the characteristics of good and innovative problem-solving teaching strategies, we performed an analysis of a number of articles published between 1985 and 1995 in high-standard international journals, describing experimental research into the effectiveness of a wide variety of teaching strategies for science problem solving. To characterize the teaching strategies found, we used a model of the capacities needed for effective science problem solving, composed of a knowledge base and a skills base. The relations between the cognitive capacities required by the experimental or control treatments and those of the model were specified and used as independent variables. Other independent variables were learning conditions such as feedback and group work. As a dependent variable we used standardized learning effects. We identified 22 articles describing 40 experiments that met the standards we deemed necessary for a meta-analysis. These experiments were analyzed both with quantitative (correlational but small group learning or collaborative learning will help students to adapt noble values that can be applied in their daily life. It is like training the students to appreciate the diversity and the differences that exist in an individual. In collaborative learning, students learn and work with others who have different features and perspectives (Wiersema, 2002; Cooper, Cox, Nammouz, Case, & Stevens, 2008). The outcomes of this research also showed that the mean different between conventional approach and SM-AEROMECH module on circular measure topic is not significant. This also implies that the use of conventional approach and SM-AEROMECH module has an equal impact on students' achievement. Learning circular measure topic through SM-AEROMECH module also can help in changing

students' attitude and achievement if the module is modified to meet the students and teachers technologies literacy level.

The effect of gender to students' achievement for circular measure topic is not significant. The results of this study showed that there is no gender difference on mathematics performance in circular measure topic. These results are consistent with the findings of Kashefi et al., (2017) that females are closing the gap in mathematics which was traditionally in favour of males. The descriptive statistics shows that mean score of male students is higher than female students' achievement in circular measure topic using conventional approach (Zakaria et al., 2012)Malaysia. The research examined the differences in mathematics anxiety according to gender as well as the differences in mathematics achievement of students based on the level of mathematics anxiety. The study involved 195 Form Four students (86 male and 109 female). This is because male students are more interested in conducting problem solving activities using concrete materials than abstract materials. They are more confident in handling real and routine questions compared to virtual questions. This is in line with the study conducted by Chipangura and Aldridge (2016) stating that mathematics activities in physical environment can help to understand better and assist them to improve mathematical conceptual and procedural. Male students' observation tendency in physical classroom reported more on cognitive and emotional engagement compared to female students. This will cause the male students interact with mathematics experiences in the physical environment (Rimm-kaufman, Baroody, Larsen, & Curby, 2015).

Female students' achievement increased compared to male students when learning circular measure topic using SM-AEROMECH module. This is because girls are comfortable with the approach and strategic learning that is integrated in the Multimedia Approach. Female students feel comfortable in learning the topic because the content and problems assimilated

with colourful media and technology (Divjak, Ostroski, & Hains, 2010). This caused them to be more convinced and active in learning the Circular Measure topic. This findings is equivalent to the study of Keter, Wachanga and Anditi, (2016)the academic performance of Kenyan students in the subject in secondary schools has remained below average over the years. The fundamental challenge facing the teaching of chemistry is how to enhance students' motivation in the subject. Although Computer Based Cooperative Mastery Learning (CBCML stating that computer-assisted material can change achievement, attitudes and motivate female students to learn science and mathematics based subjects. This may be due to the integration of various strategies and approaches that can meet the learning styles of female students. This allows students to achieve engagement in learning styles of female students. This allows students to actively engage learning activities conducted in the SM-AEROMECH module. They collaboratively and mutually support each other in the group to achieve learning outcomes.

Conclusion

SM-AEROMECH module and conventional approach did not show a significant difference on post mean score of CMT. Students' achievement is the same when SM-AEROMECH or conventional approach is used in leaning of circular measure topic. Other than that, the main interaction of gender also does not show significant effect towards students' achievement of circular measure topic. Both male and female students have the same or similar impact on students' achievement of circular measure topic. The outcome of the research also shows there was no significant interaction effect between group and gender on students' achievement of circular measure topic. The use of the SM-AEROMECH module did not succeed to change the level of students' achievement of circular measure topic. Probably the module needed to be used for a long period time to see more appropriate outcomes. According to Crano William and Radmila (2008) attitude

and achievement of students can be changed when an act is repeated for a long period of time. Changes in learning the Circular Measure topic activities will cause the time that students use to perform activities in SM-AEROMECH module to be longer. This will help students build positive attitudes towards the topic and also will help to improve the achievement of the students. Further research is needed because all findings of this research is not significant. The limitation in this research is due to cost and time. Further research needs some improvement such as developing SM-AEROMECH module for other topics, using different research location, increasing the number of participants, using different methodology and analysis, and increasing time of research to get more effective results.

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Conflict of Interest

The author declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Note

This paper is part of a PhD thesis. Title of the thesis is "The Development and Effectiveness of Interactive SM-AEROMECH Module in Increasing Achievement and Mastery of Inventive and Digital Skill in Circular Measure Topic". The research was conducted at a Malaysia secondary school and the participant is only from 4th grade. The PhD candidate studies at the National University of Malaysia. This thesis is not yet available in the repository.

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