The Effectiveness of Pro-Math Challenge Module to Improve Knowledge, Perception, Attitude and Inclination of Students in Mathematics Subject

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ABSTRACT

This paper presents an empirical finding from a research that implementing a Pro-Math Challenge module for form three students in Sekolah Menengah Kebangsaan Gunung Rapat Setia, Ipoh, Perak Malaysia. The objective of this study is to identify the effectiveness of the module in improving students' mathematical knowledge, which categorized as the Science, Technology, Engineering and Mathematics (STEM) proficiencies. Implemented in a STEM program, the students' responses on the module were analyzed with a questionnaire survey to measure four criteria namely knowledge, perception, attitude and inclination. The results from a Wilcoxon Signed-rankas test have revealed that each of the criteria has a statistically significant difference on the increment of students' understanding after the Pro Math Challenge module was implemented. Overall, half of the students strongly agree that the Pro-Math Challenge module implemented in the STEM program was beneficial to them and has given a good impact to them.

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1. Introduction

STEM is a new term invented in this century refers to Science, Technology, Engineering and Mathematics. Science is everywhere in the world around us. Technology is expanding into every aspect of our lives. Engineering can be seen in a new technology of development. Meanwhile, Mathematics involves in every occupation and every activity we do in our daily activities. Therefore, STEM covers every part of our lives. By exposing students to STEM will support them with opportunities to explore STEM with related concepts, will eventually develop their passion in the learning. A STEM-based curriculum will inculcate student interest to learn in detail. Having activities that show real life implication of STEM can pull the ideas presented in school and help them to understand better in real life problems. Students can see through STEM that the theories and concepts they are learning now is pertinent to their future.

Acknowledging the advantages of STEM, this study has been initiated to identify the effectiveness a Mathematical Challenge module that has been implemented in a STEM program for students to improve their knowledge, perception, attitude and inclination towards Mathematics subject. There were five activities provided for students in the Pro-Math Challenge module. The first activity was Magic Humpty Dumpty. The objective of this activity was to identify the equipment used to measure egg density and the difference in density between chicken eggs and quails. Based on the result of this activity, students were aware of the amount salt needed to allow chicken eggs to float in the middle of water, which was not submerged and did not arise completely. Besides that, students can determine the difference in density between chicken eggs.

The second activity was High the Pillar. Students must identify the equipment used to measure the height of the pole. They need to make an estimation of the height of the flagpole. As a result, they can know the height of the pole and they can apply the Pythagoras Theorem method to measure the height of other things than the pole. In order to test the students on probability, we provide activities namely as NIPS's Density Quest. From this activity, students can make estimation of a percentage based on collected data.

The next activity was Three Musketeers. In this activity, students can learn how to plot on the graph paper to produce an image. At the end of this activity, students can make estimated calculation on graph paper according to the coordinates supplied.

The last activity was called as Fighter Jet. This activity allowed students to think creatively and thoroughly in completing the given project. They were required to produce the maximum nine sets of fighter jet in a same size by using one sheet of A4 paper. At the end of this activity, students need to think creatively and focus on completing the task given.

2. Literature Review

Current development in Malaysia has started to show deep interest and exertions on behalf of the Malaysian government to implement the STEM in schools or university level. However, not all students are mentally prepared for Science and Mathematics subjects in school particularly. Many researches have been done to find solutions to enhance students' interest in Mathematics subject in school or even in university level. Nowadays, the way researchers want to spark interest and build students' competencies in Mathematics is usually by using technology.

Despite the widely accepted notion that all technology-based activities are inherently engaging, the evidence regarding their motivational effectiveness is mixed[1]. The empirical literature supports that persistence and success in STEM careers may be rooted in students' identification with the roles and work of STEM professionals[2]–[4]. Many approaches have been introduced to inculcate students' interest on STEM.

Researchers in [5] found that students' self-efficacy for scientific inquiry before using a Multi-User Virtual Environment (MUVE) called River City was related to their behaviors within the virtual world. Furthermore, researchers in [6] explored middle school students' science learning within a computer-enhanced Problem Based Learning (PBL) environment called Alien Rescue. They found that students' achievement and self-efficacy increased after participating in Alien Rescue. Reported in [7], the researchers found that individuals watched a virtual representation of themselves, were experiencing the benefits of exercising, these individuals were significantly more likely to engage in exercises after the intervention was done. Researchers also reported greater gains in self-efficacy for pursuing engineering careers when participants saw virtual avatars on a computer interface who looked like themselves[8]. Researchers also found that a hypermedia environment enhanced the development of students' interest but not their utility value beliefs[9]. In [10], the use of The Adventures of Jasper Woodbury videodisc activity led to gains in students' mathematics interest,

although these gains appeared to result both from the technology as well as from teachers' beliefs and instructional practices.

It has been described in [11] that the STEM curriculum has a continuum of increasing levels of integration from multidisciplinary to interdisciplinary to transdisciplinary. Mathematics is a part knowledge of STEM. Students' attitude towards Mathematics is affected by factors such as parental influences, teacher affective support and classroom instruction [12]. With strong feelings and high expectations, student teachers can perform to their optimum in teaching Mathematics. The usefulness of Mathematics in their career and future life is another driving factor that could enhance their performance as Math teachers irrespective of their gender. Researchers in [13] found the effect of Mathematics knowledge for teaching on students' achievement, with the creative and innovative approaches will help the student to discover more about Mathematical knowledge. Mathematics instruction at elementary and high schools should equip students with conceptual understanding of Mathematical concepts and authentic applications to provide early positive feelings and attitudes towards Mathematics. Teacher education programs should provide pedagogical training to trainee teachers who have negative attitudes towards Mathematics. Researchers in [14] also described that those with better academic performance theoretically have more positive attitudes towards the Mathematic subject as compared to those with poorer academic performance. Furthermore, it has been clearly explain in [15] that the role of teachers and schools with better teaching methods, more motivated teachers or better course books will increase the attitudes of student to explore more about Mathematics.

3. Research Method

3.1 The survey data

The data obtained in this study was collected from secondary school students in Sekolah Menengah Kebangsaan Gunung Rapat Setia, Ipoh participated in the Mathematical Application Modul Program with the proposed Pro-Math Challenge module. This program was joined by 75 number of students from the form three classes as well as 20 students from Universiti Teknologi MARA (UiTM) who played their roles as facilitators. The questionnaire was divided into four sections, which are Knowledge, Perception, Attitude and Inclination towards the given mathematics module. The purpose of the questionnaire is to evaluate all the four factors towards Mathematics subject before and after attending the program.

3.2 Median and Interquartile Range

The Median and Interquartile Range was used to compare student's knowledge, perception, attitude and inclination before and after attending the Pro-Math Challenge Program using the given module. The median value is 50th percentile or in the middle of distribution with 50% of the scores that are larger than median and another 50% of the scores are smaller than median value. The Interquartile range is the difference between the third quartile and the first quartile. It defines about the middle half of values in the distribution.

3.3 Wilcoxon Signed-Rank Test.

Wilcoxon Signed-Rank Test was employed to examine the effectiveness of the Pro-Math Challenge module in the program. This method is used because this study involved two dependent samples and the measurement scale of data is ordinal. In addition, the assumptions of the Wilcoxon Signed-Rank Test which is the paired data were obtained from random sample and the distribution of population of differences is approximately symmetric about their median was gratified. According to [16], the procedure of Wilcoxon Signed-Rank Test is as the following steps.

i. Find the differences between before and after.
ii. Find the absolute value of each difference and rank the value from lowest to highest.
iii. Assign each a rank positive or negative sign, according to the sign in first step.
iv. Find the sum of positive ranks and the sum of negative ranks separately.
v. Select the smaller of the absolute values of the sums and used it as w_s.
vi. Find the value of Z-score as in the following equation (1).

$$Z = \frac{w_s - \dfrac{n_1(n_1 + n_2 + 1)}{2}}{\sqrt{\dfrac{n_1 n_2 (n_1 + n_2 + 1)}{12}}} \qquad (1)$$

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 presents the median and Interquartile range (IQR) of collected data according to each component(factor).

Table 1. Summary statistics on sample of (n=75) students

Component	Before	After
Knowledge	(Median=3.0; Q_1=3.0; Q_3=4.0;IQR=1.0)	(Median=4.0; Q_1=3.5; Q_3 = 4.5;IQR=1.0)
Perception	(Median=4.0; Q_1=3.0; Q_3=4.0 IQR=1.0)	(Median=4.0; Q_1=3.5; Q_3=4.5 IQR=1.0)
Attitude	(Median=3.0; Q_1=3.0; Q_3=4.0 IQR=1.0)	(Median=4.0; Q_1=3.5; Q_3 = 4.5;IQR=1.0)
Inclination	(Median=3.0; Q_1=3.0; Q_3 = 4.0;IQR=1.0)	(Median=4.0; Q_1=3.0; Q_3=5.0 IQR=2.0)

The median value explained about the 50th percentile. Half the students responded are greater than (or equal to) the median and half are smaller. Thus, based on Table 1, it shows that half of the student responded "Neutral" for Knowledge Attitude and Inclination, "Agree" for Perception before the program. However, after the program held, half of the student found to be "Agree" for the Knowledge, Perception, Attitude and Inclination.

Equally important measure that was used to describe statistic is interquartile range. Interquartile range (IQR) defines the difference between the 75th and 25th percentile. Based on Table 1, it was found that IQR before the program held for Knowledge, Perception, Attitude and Inclination is equal to one scale. Meanwhile, IQR after the program for Knowledge, Perception and Attitude does not change except for Inclination. It shows that before the program began, 50% of the students answered less than "Neutral" for Knowledge, Attitude. Meanwhile 25% of the students answered "Neutral",50% answered between "Neutral" to "Agree" for Perception and Inclination and another 25% of the students answered more than "Agree" for Knowledge, Perception, Attitude and Inclination. Conversely, 50% of the students answered "Agree" for Knowledge, Perception, Attitude and Inclination, another 25% of the students answered between "Agree" and "Strongly Agree" for Knowledge, Perception, Attitude and Inclination and the remaining 25% of the student answered other than "Strongly Agree". Further explanation conducted based on each of the component involved.

4.2 The Effectiveness of Pro-Math Challenge Module according to Knowledge, Perception, Attitude and Inclination

The Wilcoxon signed rank test has been used in order to test the effectiveness of the Pro-Math Challenge module in the STEM program and the result is presented in Table 2.

Table 2. Wilcoxon Sign rank testing for Effectiveness

Component	Wilcoxon Sign Rank Test
Knowledge	*Z= 6.771, p-value=0.000***
Perception	*Z= 4.404, p-value=0.000***
Attitude	*Z= 5.424, p-value=0.000***
Inclination	*Z= 5.424, p-value=0.000***

A Wilcoxon Signed-ranks test revealed that each Knowledge, Perception, Attitude and Inclination of students has statistically significant difference in the increment for the tested Mathematics subject after the Pro-Math Challenge module has been implemented (Knowledge z = 6.771, p < .005, with a large effect size (r = .78)), (Perception z = 4.404, p < .005, with a large effect size (r = .51)), (Attitude z = 5.424, p < .005, with a large effect size (r = .63)) and (Inclination z = 5.424, p < .005, with a large effect size (r = .63)).

4.3 Students' Feedbacks on the Pro-Math Challenge Module

Table 3 presents the students' feedback according to the item in the given module.

Table 3. Students' Feedback on Pro Math Challenge Module

Item	Median (Md)
The modules are implemented according to Form 3 level of students	5
Overall, this program benefits me well.	5
Overall, this program has a good impact on me	5

The table shows that students perceived strongly agree on the Pro-Math Challenge module in the STEM program (Md=5 'Strongly agree'). They also found that the overall STEM program benefits them well (Md=5.00 'Strongly agree') and has received a good impact (Md=5.00 'Strongly agree').

5. Conclusion

The Pro-Math Challenge Module introduced in this study has been empirically tested to significantly improve the students' knowledge, perceptions, attitudes and inclination after the implementation. The teachers have to identify appropriate approaches to make mathematical theories and concepts as a more interesting subject. Based on the observations of this study, students can easily understand the Mathematics questions and able to answer the given questions correctly with the proposed approach. It will be more interesting to study the effectiveness of Pro-Math Challenge module at other schools in the future works.

Acknowledgements

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