THE EFFECTIVENESS OF MATHS INTERACTIVE PUZZLES IN IMPROVING STUDENT PERFORMANCE FOR ENGINEERING MAHTEMATICS

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ABSTRACT

Learning strategies are procedures that facilitate a learning task. The challenge of globalisation today requires students acquire problem solving skills beside good procedure and conceptual knowledge of Mathematics. There is a need to provide students with a repertoire of strategies to enable them to know what to use when and how themselves during to solve the problems of Engineering Mathematics. The purpose of the study is to find out the effectiveness of MATHS Interactive Puzzles in improving student performance for Engineering Mathematics. This current study was aimed to identify the motivation level of students for participation MATHS Interactive Puzzles, to identity level of understanding students after participation the program and to evaluate overall usefulness of participation MATHS Interactive Puzzles. The sample of the study consist 32 respondents from semester 4 of Electrical Engineering Department. This study is a quantitative exploratory study on the strategies used by polytechnic students supported by the qualitative feedback by students using questionnaire. The study shows that majority of the students have the positive response regarding MATHS Interactive Puzzles.

Keywords: Learning strategies, Interactive Puzzles.

1. Introduction

Rapid globalization and advancement in information technology have reshaped the employment trend, making demands which emphasize on the standard and quality of gravitating towards the high achievers. Using games in the lecture is an effective tool in the learning and teaching process. Educators have employed various experiential strategies in order to improve teaching effectiveness. (Carlos *et al*., 2012).

In any learning contexts, both educators and learner are the main actors. As a main actor, educators be it lecturers and learners, that is, students play complementing role in the process of learning. Lecturers have the responsibilities to teach, guide, and motivate. Learner, on the other hand should absorb, seek and apply the skill and knowledge shared in the learning activities. (Mohd. Yusof Abdullah e*t al.,* 2012).

The subject of Engineering Mathematics curriculum has undergone major reforms. A review of the education system in Polytechnic Malaysia had been planned to meet the demands and challenges of globalisation. Engineering Mathematics is a branch of applied mathematics concerning mathematical method and techniques that are typically used in engineering and industry. Mathematics is a prime constituent and infrastruture of the education of engineering students. The main goal of mathematics learning for engineering students is the ability to apply a wide range of mathematical techniques and skills in their engineering classes and later in their professional work. (Croft and Ward, 2001).

Simi Henderson and Graham Keen (2007), Engineering Mathematics is of such importance to the engineering curriculum because it helps to lay the foundation for good analytical and problem - solving skills often required in traditional engineering work.

Mathematics subjects are prerequisite to a number of engineering subjects. Mathematics programme was to foster intrinsic motivation by helping students to develop a deep understanding of mathematics, encouraging them to expend the effort needed to learn, and organising instruction so that students experience satisfaction when they have mastered a difficult concept or skill.

Motivation is a major factor in mathematics teaching and learning, however there is some evidence to suggest that mathematics a special subject. Mathematics is often associated with certainty whereby doing mathematics means following the rules laid down by the lecturer; knowing mathemaics means remembering and applying the correct rule. (Marzita Puteh and Mahani Ibrahim, 2010)

Making Mathematics fun for some students is quite a challege; MATHS Interactive Puzzles bring together the best for building student confidence and enthusiamsm for mathematics, problem solving, and higher order thinking skills. Every student deserves to be successful and confident in polytechnic. **MATHS Puzzles** are great for that. Students love games and puzzles, so learning math while working puzzles makes learning math fun. (Hamidreza Kashefi *et al*, 2012)

Learning mathematics is not just about acquiring, mastering, computation and problem solving techniques solely about understanding definitions, arguments and proofs. In addition, it also involves reconstructing the thinking or work of other Mathematicians. (Waziri *et al.*, 2010).

Engineering Mathematics is often perceived as a difficult subject and it is associated with certainty and with being able to get the right answer. At the same time, lectures are tasked with mathematically preparing students for an increasingly technological world, however for many students, the nature of a career involving mathematics is not at all clear. (Mas Nida *et al.*, 2010).

The MATHS Interactive Puzzles is the teaching method using Crossword Puzzles for topic Statistical and probability. It didn't take long for lecturer to see educational possibilities of these word puzzles. Crossword solving involeves several useful skills including vocabulary reasoning, spelling, and word attack skills. To solve any crossword puzzle, a person must be able to identify and understand the terms being used. This often involves acquiring vocabulary or terminology in that topic. It can also involve making differentiations between smilar word or phreses. (Kerry Jones, 2007).

Crossword puzzles have been shown to be effective teaching tools of terminology, because of the need to spell items correctly to complete the puzzle, the students use results in increased care in studying as well, and when complete, can be used further as a study device. (Davis *et al.*, 2009).

All students will benefit from a variety of teaching styles and classroom activities. Students with mild general learning disablilities will benefit particularly if the teacher is aware of their individual talents, strengths, and needs before embarking on a new activity. Puzzle solving is a much more active type of learning, and will engage students with the material more than passive types of review techniques do. Crossword puzzles also have the advantage of appealing to different learning styles. Visual learners often have strong puzzle-solving skills, and feel great satisfaction when they complete one. The MATHS Interactive Puzzles can exercise the brain. It like Chess may be helpful in playing our brain. The participants can get used to style of "hints" to complete it. (Robert Allison, 2016)

Oliver Roeder (2016), the MATHS Interactive Puzzles is memorable, clever, creative and funny. The theme answer are usually the longest or shorter answer in the grid and are tied together by some clever conceit. In experiential teaching and learning students are involved directly in an activity, discuss the activity and build awareness and insight their new understanding into their daily lives.

Zbigniew and Matthew (2008) further describe educational puzzles explain some universal Mathematical problem solving principles. This is a very important, as easy to remember puzzles increase the chance that the solution method. Besides being a lot of fun, the puzzle-based learning approach does a remarkable job of convincing that Mathematics is not that scary. Puzzles are educational, but they illustrate useful and powerful problem solving rules in a a very entertaining way.

One technique is to use crossword puzzles which can be tailored to the particular concept of interest. Particiapation in the circumstances occurs when students influenced by factors such as sosio-cultural, cognitive and affective often lead to student participation and interaction with other students, Mohd. Yusuf Abdullah *et al.* (2012).

According to Martin *et al*. (2013), a crossword puzzle is a game in which word, guessed from their definitions, is fitted into a diagram of white and black squares. The crossword has words written horizontal (across clues) and words written vertically (down clues). The pattern of black squares usually serves to separate each word from adjacent words. Correctly deciphering a crossword requires correct spelling, which for students may mean practising dictionary skills. Making inferences, evaluating choice, and drawing conclusions are important skills required for completing crossword puzzles.

This study was carried out in order to get view on the effectiveness of MATHS interactive puzzles in improving students performance for engineering mathematics. Thus, this study is considered to give some contribution to the effort to develop a holistic conception of MATHS Interactive Puzzles from the perspective of students.

Objective of study were as follow:

a. To identify the motivation level of students for participation MATHS Interactive Puzzles.
b. To identify level of understanding students after participation MATHS Interactive Puzzles.
c. To evaluate overall usesfulness of participation MATHS Interactive Puzzles.

2. Scope of study

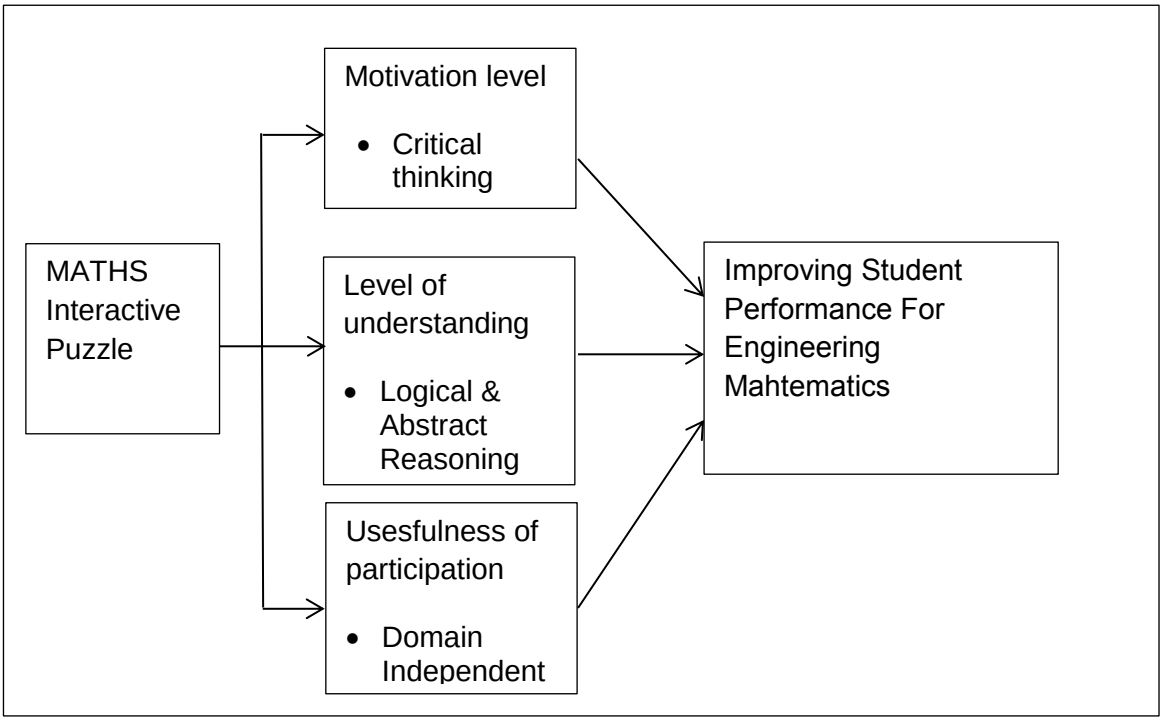


Figure 1. Review of framework
(Adaptation Waziri *et al.*, 2010).

MATHS Interactive Puzzles is a way of learning Mathematics. The puzzles are stated in form of word problem or definition of the problem throught reasoning and tell the answers. From The MATHS Interactive Puzzles, researcher will identify the motivation level of students, level of understanding and evaluate overall usesfulness of participation MATHS Interactive Puzzles. All the three item will improving Student Performance For Engineering Mahtematics. The students can applying sometimes that has been learned and understood. This study provides a glimpse at the use of crossword puzzles for learning process and impact they have on students learning for the improving the performance.

2. Method

2.1. Participants and procedure

A total of 32 fourth semester students from Electrical Engineering Department in Polytechnic Ungku Omar. They were selected from students enrolled in the DBM3023 (Electrical Engineering Mathematics). The questionnaires were distributed to the students.

2.2. Instruments

Data were collected from the participants using questionnaires. The first part of the questionnaire gather information pertaining to the gender, race and program akademic. The second section of the questionnaire identified the motivation level of students for participation MATHS Interactive Puzzles. The third section identified level of understanding students after participation MATHS Interactive Puzzles. The fourth section on evaluate overall usesfulness of participation MATHS Interactive Puzzles.

Table 1. Scoring Likert Scale Items

Scale	Measurement
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

(Source: Chua Yan Piaw, 2006)

2.3. Data Analysis

The Data obtained from the questionnaires were analyzed and presented using descriptive statistics such as mean and standard deviations.

3. Results

3.1. Students Profile

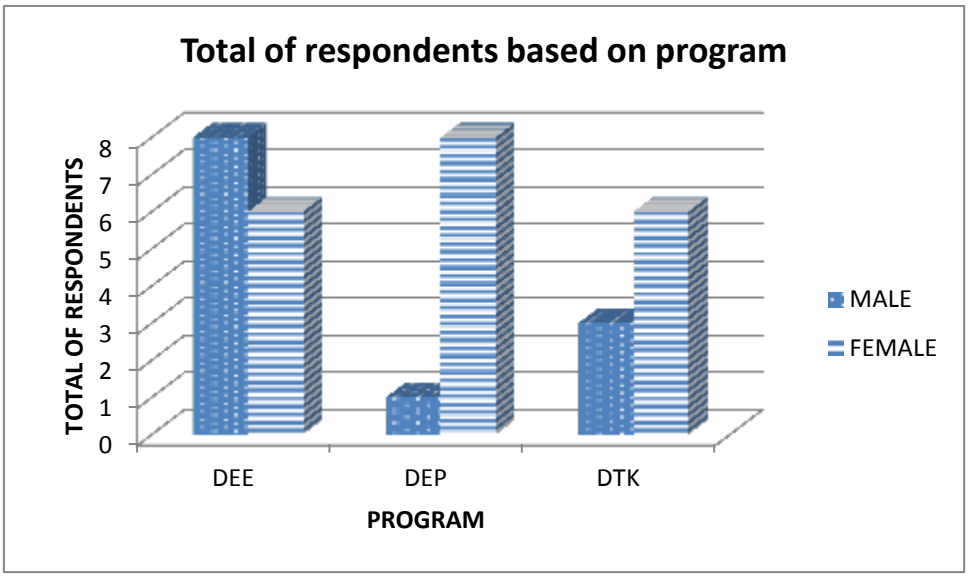
The questionnaire was administered to 32 students. The student sample was a convenience sample in which students in three programs were invited to participate. The three programs are the Diploma in Electrical and Electronic Engineering (DEE), the Diploma in Electronic Engineering (Communication) (DEP) and the Diploma in Electronic Engineering (Computer) (DTK). The participants in the study were not equal in terms of gender with 12 (38%) males and 20 (62%) females. For the program DEE, there have 8 (57%) males and 6 (42%) females. For the program DEP, there have 1 (11%) males and 8 (89%) females. For the program DTK, there have 3 (33%) males and 6 (67%) females. The student's profiles based on gender are shown in Table 2. Most of the students are Malay students (20, 62.5%), follow by Indian students (7, 21.9%) and Chinese students (5, 15.6%) as the Table 3.

Table 2. The student's profile based on gender

Program	Male	Female	Total
DEE	8 (57%)	6 (42%)	14
DEP	1 (11%)	8 (89%)	9
DTK	3 (33%)	6 (67%)	9
Total	12(38%)	20(62%)	32

Table 3. The student's profile based on race

Program	Malay	Chinese	Indian	Total
DEE	12 (85.7%)	1 (7.1%)	1(7.1%)	14
DEP	0 (0%)	3 (33.3%)	6 (66.7%)	9
DTK	8 (88.9%)	1 (11.2%)	0 (0%)	9
Total	20(62.5%)	5(15.6%)	7 (21.9%)	32



Graph 1. The total of respondents based on their program

3.2. Descriptive measure the motivation level of students

Table 4 shows that students had moderate level of motivation in participating MATHS Interactive Puzzles. Students reported highest mean for "I enjoy working on the puzzles based on critical thinking," followed by "The MATHS Interactive Puzzles program met my educational needs and expectations," "The MATHS Interactive Puzzles program reasonable for the program purpose and time frame," and "The MATHS Interactive Puzzles program requirements were clearly explained."

Table 4. Means and standard deviations for the motivation level of students

No	Item	Mean	Standard Deviation
1	The MATHS Interactive Puzzles program met my educational needs and expectations	4.4063	0.55992
2	The MATHS Interactive Puzzles program requirements were clearly explained	4.2812	0.81258
3	The MATHS Interactive Puzzles program I enjoy working on the puzzles based on critical thinking.	4.3438	0.70066
4	I enjoy working on the puzzles based on critical thinking.	4.6250	0.60907
	Total	4.4141	0.67055

Generally, the scores shown in Table 5 on the level of understanding students after participating the MATHS Interactive Puzzles with mean of 4.4896. Overall, the students were understanding to complete the MATHS Interactive Puzzles. In fact, most students could cope with the requirement of question in topic Statistic and probability. They were able to involve themselves in the program MATHS Interactive Puzzles. All the means for the item in this factor were in the range of 4.3750 to 4.5937.

Table 5. Response to the level of understanding students after participation MATHS Interactive Puzzles.

No	Item	Mean	Standard Deviation
5	I can develop positive attitudes towards the MATHS Interactive Puzzles	4.5937	0.61484
6	I can learn abstract reasoning based on puzzles.	4.3750	0.65991
7	I can learn to be creative and logical.	4.5000	0.67202
	Total	4.4896	0.64892

The students demonstrated moderate level of the overall usesfulness of participation MATHS Interactive Puzzles with mean of 4.5521 (refer table 6). The mean for items in this factor were in the range of 4.5312 to 4.5652. The participants found that the program can create domain independent and look forward for participating the program.

Table 6. Responses to the overall usesfulness of participation MATHS Interactive Puzzles.

No	Item	Mean	Standard Deviation
8	I can show significant improvement in Math skills.	4.5312	0.62136
9	I look forward to my participation in the program.	4.5652	0.66901
10	I like the program for the create domain independent.	4.5625	0.66901
	Total	4.5521	0.65313

4. Discussion

4.1. The motivation level of students for participation MATHS Interactive Puzzles

The MATHS Interactive Puzzles is the program how crossword puzzles can be used in applied statistical topic to assist the students in learning basic statistical terminology. McKeachie (2002) describe that the students learn better if they are engaged in, and motivated to struggle with, their own learning. The MATHS Interactive Puzzles can help students learn basic statistic concepts by providing different ways to represent the basic terms. In order to solve a crossword puzzle, a student must be able to identify, analyze, and understand the terms being used in a vocabulary and terminolgy. The item 4, "I enjoy working on the puzzles based on critical thinking" score the highest mean of 4.6250. Likewise, Hamidreza Kashefi *et al.*, (2012), sstudents can organize ideas, step by step, to complete a task correctly. They will be able to visualize an object in the mind's eye. The MATHS Interactive Puzzles have the advantage of appealing to different learning styles. The participants need comprehend the meaning of subject matter. Puzzle based learning originated with the goal of enhancing the general problem solving and critical thinking skills. The MATHS Interactive Puzzles program met my educational needs and expectations. Learning Puzzles is enhanced by having students become aware of and confront their misconception. Zbigniew and Matthew (2008) state that learning is enhanced if students have opportunities to express ideas and get feedback on their ideas from MATHS Interactive Puzzle. The MATHS Interactive Puzzles program requirements were clearly explained. Acoording to Michael and Matthew, 2002, the ideas of probability and statistics are very difficult for students to learn and often conflict with many of their own beliefs. After giving the explanations about the MATHS Interactive Puzzles, students can understand basic concepts. Students may be able to answer some items correctly. The MATHS Interactive Puzzles program reasonable for the program purpose and time frame have support by Davis (2009), the length of the time students spend using these methods and aids should be looked at. The students can done the puzzle to solve the MATHS Interactive Puzzle at the specified time. Weisskirch (2006) found that students were more likely to complete the

puzzles when given time to do them in class, and when given the chance to collaboratively with others. Gurung and Daniel (2006) support that students tend to gravitate towards study techniques that require less time and effort.

4.2. The level of understanding students after participation MATHS Interactive Puzzles

"I can develop positive attitudes towards the MATHS Interactive Puzzles" is the highest mean in this part. It score means about 4.5937. According to Robert Allison (2016), students like doing crossword puzzles were expressed by composer and lyricist Stephen Sondheim: "The nice things about doing a Maths Interactive Puzzles is, you know there is a solution." The MATHS Interactive Puzzles are a refreshing interlude from daily life. The mean score of the item 7, "I can learn to be creative and logical" is 4.5000. Correctly deciphering a crossword also requires exact spelling, which for students may mean practicing dictionary skills. Other important skills required for completing these puzzles include making inferences, evaluating choices, and drawing conclusions. Another benefit of using crossword puzzles in the classroom is that they are associated with recreation, and can be less intimidating for students as review tools, Oliver Roeder (2016). The item 4, "I can learn abstract reasoning based on puzzles" is the lowerst mean score in this section. Associating what has been learned, understood and applied with subsequent learning with the help of puzzles. McKeachie (2002), suggest some advanges in the use of games like crossword puzzle solving because students play an active role, make decisions, solve problems, and react to the results of their own decisions. Waziri *et al.,* (2010) describe learning Mathematics is not just about acquiring, mastering computational and problem solving techniques, or solely about understanding definition, arguments and proofs. In additional, it also involves reconstructiong the thinking or work of other mathematician.

4.3. The overall usesfulness of participation MATHS Interactive Puzzles.

"I look forward to my participation in the program" is higest mean score in this section, The respondents shows that they enjoy the Interactive Puzzles and that it does develop their thinking skills. Participation between students is integral in the process of learning. Mohd. Yusuf Abdullah *et al* (2012), it was found that students, who are active particiapants, tends to have better academic achievement, compared with students, who are passive in participation. The item 10, "I like the program for the create domain independent" show that Puzzle-based learning is a pedagogical experiment in progress. The goal is to foster general domain independent reasoning and critikal thinking skills that can lay a foundation for problem-solving in future course work. Carlos *et al* (2012), a good educator must create tasks that align eith the student's level of learning capability. A unique individuals, students will do better by avoiding the use of common practise. In such context, it is possible for students to live the experience and control their own learning process. The item 8, "I can show significant improvement in Math skills" is based on Robert Eaxtrom *et al* (2002), the MATHS Interactive Puzzles is a new way of learning. Its better productity than traditional learning and increases critical thinking and participation. According to Davis *et al*., (2009), for some lecturer, implementing alternative methods of teaching may be difficult, as many lecturer prefer to use the traditional methods, not as a replacement. MATHS Interactive Puzzle is the alternative way can be introduce for teaching method. Weisskirch (2006) discribe they are also a useful tool as most people are already familiar with them, which reduces the need to explain directions, saving class time.

5. Conclusion

Using games in the lecture is an effective pedagogy. The MATHS Interactive Puzzles may prove to be a meaningful learning experience for building, understanding, and improving the retention of terms associated with a particular knowledge area in Engineering Mathematics. It also benefits students who are in the process of learning theory of topic statistic. With these benefits in mind, the crossword puzzle stands out the rest as a classroom tool.

The research by Carlos *et. al.* (2012), an alternative use of crossword puzzles as an educational strategy by combining both design and solution as student activities in the classroom. The results are encouraging for those interested in employing a non-traditional teaching strategy for the purpose of improving learning and concept.

The MATHS Interactive Puzzles have been used successfully in many different disciplines, showing their versatility and flexibility improving student performance in Engineering Mathematics. The benefit to use crossword puzzle can teach the students alternative techniques to studying, impacting cognitive development. Additionally, these puzzles are often perceived as being a recreational activity, therefore making them more enjoyable and less threatening than traditional teaching techniques.

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