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NEED ANALYSIS FOR THE DEVELOPMENT OF A GAME-BASED LEARNING KIT ON ISOMETRIC TRANSFORMATIONS

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ABSTRACT

Teaching and learning methods give a huge impact on students' understanding and on-going learning in the classroom. Currently, some teaching and learning methods have become a teacher's choice and one of them is the Game-Based Learning (GBL). This study aims to identify the extent to which GBL method has been accepted by Malaysian teachers and to identify the topics in Form 2 Mathematics which require GBL method. This study used a questionnaire involving 85 respondents among teachers in Muallim and Batang Padang districts in Perak, Malaysia. The data collected was analysed using descriptive statistics namely the percentages. The findings showed that 10.6% of the teachers experienced using kit, while the remaining 89.4% never experienced using the kit in teaching and learning. This study also found that the topic of Isometric Transformations achieved the highest percentage (17.9%) as the topic of choice for teachers, which indicated that GBL should be integrated in this topic during the development of the kit. To date, there is no documented kit which is specifically designed to guide teachers in how to implement a GBL kit in teaching and learning on the topic of Isometric Transformations. It was concluded there is a need to develop a GBL kit for Isometric Transformations which would enhance the achievement and

motivation among students to enable them to compete globally. The implication is, giving guidance to any party whether teachers, researchers or ministry to develop teaching kits for various subjects especially Isometric Transformations.

INTRODUCTION

This era of globalization has seen education plays a key role in the economic growth and development of a country (Ministry of Education Malaysia (MOE), 2013). This is because the success of a country depends on the knowledge, skills, and competencies of the people. Complex and integrated education systems take a long time to see the impact of the transformation being implemented. Therefore, according to Malaysian Education Blueprint (PPPM) 2013-2025 (MOE, 2013), the MOE is encouraged to take bold and fast action as the changes that are intended are important and must be implemented immediately.

The education system in Malaysia emphasizes the development of strong knowledge content through subjects such as Science, Mathematics and Language (MOE, 2013). Mathematics is an important subject and requires students to contribute ideas to solve mathematics problems. To enhance students' motivation in mathematics learning, teachers ought to contemplate emphasising student participation and task organisation in class to enhance students' perceptions of their learning environment, attitudes and achievement in mathematics (Opolot-Okurut, 2010). Therefore, appropriate approaches, methods, strategies and techniques can assist teachers in bridging skills development and understanding of mathematics comprehensively.

Teaching and learning process that uses methods such as games will make students more motivated to learn because students are engaging in activities that are relevant for learning (Plass, Homer, & Kinzer, 2015; Nurul Hafizah, Samsiah, Mahani, & Nor Liza, 2019). Chin and Effandi (2015) stated that playing games in Mathematics can increase students' interest in mathematics learning. They also agreed to the opinion of Plass et al. (2015) which expressed interest and motivation are important to trigger a sense of curiosity which in turn leads to a deeper exploration of what is being learned. In addition, the game methods can also improve students' perception on learning environment, their confidence as students and their achievement in Mathematics (Chen, Liao, Cheng, Yeh, & Chan, 2012). Students are more likely to engage in learning when they have a motivation in themselves to learn. Game-Based Learning (GBL) can help teachers to relate skills development and understanding development in mathematics (Ismail & Mohd Suhaidy, 2011). Games not only stimulate students' interest in mathematics, but can also enhance student creativity and knowledge.

Furthermore, a study by Norma Aida and Abdul Razak (2009) found that the teaching method used for the topic Transformations was the traditional teaching method of chalk and talk. The weaknesses of the teaching strategy among federal school teachers in Malaysia reported in the 1990's by the Inspectorate of Federal Schools were repeated nowadays, in particular,

teacher-centered teaching, chalk and talk teaching, and exam-oriented teaching (Fatin Aliah, Mohd Salleh, Mohammad Bilal, & Salmiza, 2014).

Typically, teaching and learning of Mathematics in schools is less emphasis on visualisation due to the time constraints (Samsudin & Fatimah, 2004). However, Samsudin and Fatimah (2004) found that if it is practiced in the early stages, this process becomes a routine for teachers and students thus making students more capable of solving mathematical word problems. Moreover, teaching and learning that require a lot of visualisation will become easier if teachers do not use traditional teaching methods because this method requires time for teachers to draw and so on (Norma Aida & Abdul Razak, 2009).

A lot of research abroad has studied teaching methods using GBL in Mathematics subjects. For example, in Virginia, Carr (2012) conducted a study on fifth-grade students. Meanwhile, in Taiwan, Chen et al. (2012) conducted a study on fourth-grade students and Lin et al. (2013) then conducted a study on sixth-grade students. In Malaysia, several studies in various subjects have been conducted to study teaching methods using GBL. For instance, Nor Azan, Azizah, and Yue (2009) studied the GBL method in History subjects, Junaidah et al. (2016) studied the impact of GBL method in teaching and learning on Accounting Principles while Chin and Effandi (2015) studied the impact of GBL for pre-school mathematics subject.

In spite of the wide study of GBL as mentioned, however, from the aspects of mathematical content, the level of study and type of product developed are different from this study. Most of the studies only focus on product development such as digital game learning models, teaching aids, and digital gaming systems, in contrast to this study which mainly will develop a kit that integrates the method of GBL.

This study, therefore, aims to develop a GBL kit for the subject of Mathematics for Form 2 students. In this paper, the first phase of the study will be discussed which is related to the analysis phase of the Design and Development Research (DDR) (Richey, Klein & Nelson, 2004). The main aim of this need analysis study is to identify the extent to which GBL method has been accepted by Malaysian teachers and to identify the topics in Form 2 Mathematics which require GBL method. It is hoped that this study will successfully develop a kit that integrates the GBL which contributes as an alternative method of teaching and learning mathematics, thus attracting students in learning, especially in the topic of Isometric Transformations.

LITERATURE REVIEW GAME-BASED LEARNING

According to Plass et al. (2015), GBL is a teaching method that involves the use of game elements to motivate students engaging in assigned tasks to make them more interesting. Several studies have found the implementation of GBL method in the classroom can improve students' achievement, motivation and interest in mathematics learning (Chin & Effandi, 2015; Naik, 2017; Lin,

Tseng, Lee, Wang, Tsai, & Yi, 2018; Boghian, Cojocariu, Popescu, & Mata, 2019). Moreover, games are not only stimulating students' interest in mathematics, but can also improve students' creativity and knowledge (Papastergiou, 2009). In addition, Papastergiou (2009) also stated that students who play games in the learning process have a better performance because they are more motivated and enthusiastic than students who do not play games in the learning process.

In this kit, GBL possesses several characteristics that need to be fulfilled according to students' age and its suitability in class to achieve learning objectives. One of these is that GBL is capable of motivating students to engage in games because GBL needs students' participation. However, the game created does not necessarily be entertaining. The resulting GBL should have a clear learning objective to be accomplished in a game or scenario delivered through storytelling or narrative. The scenarios presented are reflective and can be applied to the real world experience. In addition, the GBL should give students freedom to interact in the game world and must keep up with the students' intellectual pace and abilities (Tang, Hanneghan & El-Rhalibi, 2007).

Moreover, clear feedback should be provided for every action taken by students. This characteristic is important to determine whether each action taken is right or wrong. According to Perrotta, Featherstone, Aston, and Houghton (2013), GBL approach is fun because students will see the prompt impact of their actions. Besides, during playing games, both aspects of learning and assessment can be done.

In addition, to educate many students at the same time, large scale GBL can be implemented. There were several studies concerning GBL that have been a focus on research in a number of subjects, as shown in Table 1.

Changes and innovation in educational approach should be carried out in line with current developments. Students will have the opportunity to explore their own learning experiences through GBL and are more open to the views and ideas related to the mathematical understanding of learning. Students will also be more interested to engage in every activity and experience a fun learning environment.

Table 1: Studies concerning the GBL method

Author/Year	Subject	Purpose of the Study	Impact of Study
Nor Azan Mat Zin, Azizah Jaafar, and Seng Yue Wong (2009)	History	To propose a digital GBL model for History educational games design and a development methodology that	Results indicated that students have issues when learning history. Difficulty in memorizing facts

		combined the Instructional Design and game development process.	is the main problem faced by students. Results additionally indicated that 92% students have experienced playing digital games. Findings showed that the most need of game-based history courseware are: illustrate history facts clearly, increase students' interest to learn history and learn history through creative experience.
Jennie M. Carr (2012)	Mathematics	To examine the effects of iPad use as a 1-to-1 (1:1) computing device on fifth-grade students' mathematics achievement in two rural Virginia elementary schools.	The study found no difference in mathematics achievement would exist between the experimental and control groups as measured by the fifth-grade mathematics Scott Foresman-Addison Wesley Virginia standard of learning aligned assessment. The finding indicated that instruction with the supplemental use of the iPad was not an efficient intervention for the fifth-grade students'

			mathematics achievement according to the manner in which the present investigation was conducted.
Zhi-Hong Chen, Calvin C. Y. Liao, Hercy N. H. Cheng, Charles Y. C. Yeh, and Tak-Wai Chan (2012)	Mathematics	To develop a GBL system, My-Pet-My-Quest so as for the aim to support students' mathematics learning due to the fact that the majority students in Taiwan have relatively lower positive attitude towards mathematics learning, even though their mathematics performance is prominent.	The results discovered that game quests were favoured by students in terms of enjoyment, goal orientation, and goal intensity. The results showed that the quests had a positive impact on elementary school students.
Chun-Hung Lin, Eric Zhi-Feng Liu, Yu-Liang Chen, Pey-Yan Liou, Maiga Chang, Cheng-Hong Wu, and Shyan-Ming Yuan (2013)	Mathematics	To inspect the effectiveness of using computer games for after-school remedial mastery learning and to compare the effectiveness of game-based and video-based remedial instruction incorporated with elements of mastery learning.	The results demonstrated that (a) both instructional videos and the proposed Monopoly game enhance the learning of mathematical concepts; and (b) the Monopoly game is more effective than instructional videos at leveraging the advantages of mastery learning.
Lu Chung Chin and Effandi	Mathematics	To investigate the impact of GBL activities on	The outcomes showed that the

Zakaria (2015)		children's positive learning and prosocial behaviours.	treatment group gained much higher frequency of occurrence in prosocial behaviours compared to the control group. These outcomes recommended that GBL is effective in nurturing children's positive learning and prosocial behaviours.
Junaidah Jamaluddin, Norlaila Mohd Din, Mohamad Fadzillah, and Zuhariah Husin (2016)	Accounting	To look at the impact of Accounting on the Block (AOTB) games as an alternative to conventional methods in teaching and learning the subject of Accounting Principles on students' achievement.	The results showed that there was a significant increase in student test score after the game activities were performed.
Anuradha Mathrani, Shelly Christian, and Agate Ponder-Sutton (2016)	Programming	To demonstrate a GBL approach to engage students in learning and improve their programming skills.	Findings revealed that educational games add to the fun element in learning, and students appraised the game as an efficient way to learn programming.

METHODOLOGY

The main objective of the study is to develop an Isometric Transformations kit (KitTI) integrates GBL which were conducted in three phases in the DDR research design; (1) Analysis (2) Design and development, and (3) Evaluation of the KitTI (Richey & Klein, 2007). The need analysis that highlighted in this

paper was in the first phase of the study; namely the analysis phase. The main aim of the need analysis is to gain feedback from Mathematics or Additional Mathematics teachers in Muallim and Batang Padang districts regarding the extent to which GBL has been accepted by Mathematics teachers and to identify the topics in Form 2 Mathematics which require GBL method.

The instrument for this analysis phase is the Need Analysis for KitTI Questionnaire. The questionnaire consists of two parts; namely Part A about information of the respondents and Part B about the need analysis for the development of game-based learning kit. Furthermore, the questionnaire has been validated by two experts and has been determined by its reliability index, Cohen's Kappa of 1.00. The study sample was comprised of 85 secondary school mathematics teachers and the samples were chosen through the purposive sampling technique. The survey was carried out within two weeks using the technique of mail survey. To achieve a high response rate for the survey, the reply-paid envelopes were attached and several telephone calls to the schools were done. The data collected was analysed using descriptive statistics namely the percentages.

RESULTS AND DISCUSSIONS

Eighty five teachers were responded to the Need Analysis Questionnaire; with 51.8% of them were Mathematics or Additional Mathematics teachers, while 36.4% were Head of Panel. 9.4% of respondents were Head of Department and the remaining 1.2% was expert teachers and another 1.2% were principal. Based on the teachers' educational background, 82.4% of them held a Bachelor's Degree while 15.3% held a Master's Degree. In general, the Mathematics or Additional Mathematics teachers in school held a Bachelor's Degree in their respective fields. Regarding their general teaching experience, it was found that only 4.7% of respondents had less than a year experience in teaching Mathematics or Additional Mathematics and 8.2% of them had one to five years of experience. 20.0% of them had six to 10 years' experience and 35.3% of them had 11 to 15 years' experience in teaching. Also, 31.8% of the respondents had more than 16 years' experience.

The finding shows that the most frequently used teaching approach in Mathematics or Additional Mathematics is teacher-centered, which is at 44.4% where the percentage is higher compared to the student-centered approach of 39.7%. However, the material-centered approach is much less when only 15.9% of respondents used this approach. This high teacher-centered teaching approach was further strengthened when a total of 24.3% of the respondents selected a method of explanation as the most frequently used method in their teaching and learning as well as the discussion and cooperative method, which also recorded similar percentages of 28.5% and 24.8% respectively. This clearly indicated that the teacher-centered teaching approach is still dominant at this time when the method of explanation is one of the most frequently used by respondents in teaching and learning of Mathematics or Additional Mathematics.

Sixty percent of respondents felt that the development of KitTI was a necessity while 40% thought otherwise. This 20% difference indicates that the need for GBL kit development is significant as more than half of respondents support the production of this kit. Of these, the three most topics in demand GBL kits are Isometric Transformations (17.9%), Polygons (11.0%) and Three-Dimensional Geometric Shapes (9.2%) as shown in Diagram 1. This percentage indicates that the Isometric Transformations topic was selected as the one that most needs a GBL kit.

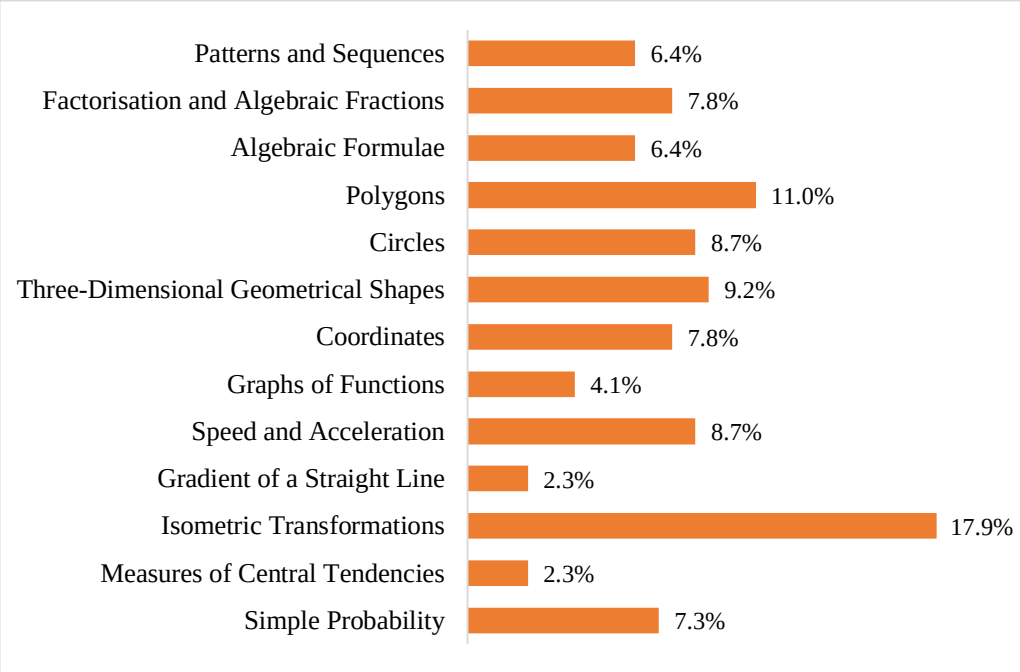

Diagram 1 GBL kit demand by topic.

The questionnaire also required respondents to determine the topic that requires visualisation and teaching aids. Through visualisation technique, students are able to imagine, visualise and explain visual processes that occur in mind (Rohani, Abdul Halim, Mohd Salleh, Mahani & Noor Azean, 2015). Visualisation techniques in teaching are important as students are more likely to consider mathematics subject difficult if they are unable to give a visual representation of mathematical concepts (Wan Fatimah & Halimah, 2001; Norma Aida & Abdul Razak, 2009). The findings show that the three topics that require a lot of visualisation are Polygons, Three-Dimensional Geometry Shapes and Isometric Transformations. Out of these three topics, the percentage of respondents selected Isometric Transformations was the highest at 17.4% as compared with Three-Dimensional Geometry Shapes and Polygons with 17.1% and 14.4% respectively. This finding indicates that improvement should be done in the topic Isometric Transformations so that students can expert visualisation technique as they can focus on understanding the problems that will help them plan and implement problem solving strategies (Lasiun, 2016).

Dienes' Theory states that concrete materials are important as a result of it will increase students' mathematical achievement, provides them higher order thinking skills, and positively affects their interests and attitudes for mathematics course (Sari & Tertemiz, 2017). This is consistent with a study by Tajularipin and Nor Azlina (2010) which states that learning involving concrete materials, equipment and resources are more effective. The highest percentage of topics requiring a lot of teaching aids was 14.9 which is both topics Isometric Transformations and Three-Dimensional Geometry Shapes. On the motivation sides, the top three percentages of the main teaching methods that will motivate students are GBL of 13.1%, problem-based learning of 13.1% and cooperative learning of 12.7%. The majority of respondents prefer GBL and problem-based learning methods over the other as the method that will motivate students.

In this study, KitTI that integrates the GBL method will be focusing on increasing students' achievement and motivation. Table 2 below shows the teachers' responses to the question which Form 2 Mathematics topics most need a GBL kit, require a lot of visualisations and require teaching aids.

Table 2: The feedback on Form 2 topics from Mathematics or Additional Mathematics teachers in Muallim and Batang Padang districts

No.	Form 2 Topics	Need a GBL Kit (%)	Require a Lot of Visualisations (%)	Require Teaching Aids (%)
1	Patterns and Sequences	6.4	2.7	4.4
2	Factorisation and Algebraic Fractions	7.8	1.1	2.6
3	Algebraic Formulae	6.4	1.3	2.6
4	Polygons	11.0	14.4	13.9
5	Circles	8.7	12.0	13.1
6	Three-Dimensional Geometrical Shapes	9.2	17.1	14.9
7	Coordinates	7.8	8.6	7.5
8	Graphs of Functions	4.1	8.3	7.5
9	Speed and Acceleration	8.7	4.8	3.3
10	Gradient of a Straight Line	2.3	4.5	4.1
11	Isometric	17.9	17.4	14.9

	Transformations			
12	Measures of Central Tendencies	2.3	2.7	3.6
13	Simple Probability	7.3	5.1	7.7
Total: 13 Topics		**100**	**100**	**100**

The use of kits among them was very small because 76 of the total 85 respondents stated that they had never used teaching kits. Regarding the production of teaching kits, only four respondents stated that they had ever produced a teaching kit. From the feedback of these four respondents, none of them produced teaching kits related to the topic of Isometric Transformations. Hence, this study should be implemented which is to develop KitTI as the majority of respondents agree there is a need to develop the GBL kit, and they also choose Isometric Transformations as the topic needed to develop the kit because there are still no respondents using the kit in this topic.

CONCLUSIONS

The finding of the study gives information that numerous Mathematics or Additional Mathematics teachers are still using a teacher-centered approach as many of them used explanation method as the most frequently used method in the classroom. This study also revealed that the topic of Isometric Transformations achieved the highest percentage, as the topic of choice for teachers that need a GBL kit (17.9%), require visualisations (17.4%) and teaching aids (14.9%). Moreover, majority teachers have chosen GBL method as one of the teaching methods that will motivate students, hence indicated that GBL should be integrated in the Isometric Transformations topic during the development of KitTI. As a conclusion, there is a need to develop a GBL kit for Isometric Transformations which would enhance the achievement and motivation among students to enable them to compete globally.

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