

USING GAME KIT FOR ENTHUSIASTIC AND INTERACTIVE LEARNING IN ADDITIONAL MATHEMATICS CLASSROOM

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ABSTRACT

Gamification is a term used to convey a gaming-based approach in a non-gaming environment. One such application is in the emergence of gamification in educational sector. Additional mathematics is a compulsory subject that is offered to science stream students across Malaysia. However, most students have problem understanding and learning the subject as the traditional educational approach is less adequate due to its ineffectiveness in increasing students' performance. To identify the root cause, a descriptive research method using survey among students is conducted. It is found that moderate number of students (n=118) have problems with additional mathematics with 3.02 as the average mean value of respondents in close-ended questionnaire conducted. The survey also yields difficulty applying concepts and tedious calculation steps as problems in the open-ended questionnaire response from students. The study also proposes a design of a game kit to aid in creating an enthusiastic and interactive learning in additional mathematics classroom. Implications of the study include that students are expected to have increased understanding as well as more interest in learning additional mathematics.

Keywords: Gamification, additional mathematics, game kit, interactive learning

INTRODUCTION

The traditional or conventional teaching method is an ineffectual and monotonous teaching method and still widely used in schools. Even though there are lots of approaches and various methods, there are still major complications faced by some schools. Therefore, an educational games or gamification will be highlighted as another approach of teaching due to the modernization civilization that is implement in the country. These will surely emphasize not only knowledge but also skills and interest in most of students.

A gamification is defined as a new method of interpreting gaming-based approach and teaching method together. This is a promising method of learning that able to increase students' interest.

In Malaysia, syllabus of additional mathematics is an elective subject taught in secondary school level, aims to provide students with a tendency towards science and technology. The additional mathematics syllabus emphasizes conceptual understanding and skills mastery where problem solving is the primary focus of the teaching and learning process. Mathematical communication skills are also emphasized in the additional mathematics learning process. As students explain the concepts and work outcomes, they are guided to use the correct and precise mathematical terms and sentences. Emphasis on mathematical communication forms the ability of students to translate a situation into mathematical models.

In this research, there are few problems that should be solved immediately, where most of the students have problems understanding the concept and eventually aren't able to solve additional mathematics questions. The noninteractive learning style also leads to a significant decrease of student interest in learning additional mathematics.

PRELIMINARIES

Gamification

The term 'gamification' has been used since around 2003 to influence online and real-world behavior. Gamification makes a game out of something and game design has certain conventions. Every game must have rules, tools, mechanics and players. Rules and tools are specific to each game, dependent on what outcomes are desired. The players are either employees or exist outside of the corporate firewall. Therefore, there are two main types of gamification – enterprise gamification and social gamification (Dale, 2014).

The gamification in education is also sometimes termed as game principles for education, gameful thinking, engagement design, or motivational design and more. This, in turn, improves the learner's motivation. Moreover, the design of game offers the learners the freedom to fail and to face and accomplish various challenges and goals respectively (Racoon Gang, 2018).

Besides that, the gamification in education, or gamification in learning, is sometimes described using other terms, which is a gameful thinking, game principles for education, motivation design, engagement design, etc. It is different from game-based learning in that it does not involve students making their own games or playing commercially made video games. It operates under the assumption that the kind of engagement that gamers experience with games can be translated to an educational context towards the goals of facilitating learning and influencing student behavior. Since gamers voluntarily spend countless hours playing games and problem-solving, researchers and educators have been exploring ways to harness videogame's power for motivation and apply it to the classroom (Yang, 2014).

According to Kapp gamification is "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems." (Kapp, 2012). Gamification is the use of game thinking, approaches and elements in a context different from the games. Using game mechanics improves motivation and learning in formal and informal conditions various definitions overlap and can be summarized as follows: Gamification is an integration of game elements and game thinking in activities that are not games (Kiryakova, Angelova, & Yordanova, 2014).

Interactive Learning

In the perspective of providing an education of the highest quality among most of students, and capitalizing on the benefits of interaction for learning, previous research has shown the benefits of a particular interactive learning environment, interactive groups (IG), to achieve the best levels of school success and group cohesion for all (Valls, 2013). Which then shows, the benefits of IG for mathematics learning has been demonstrated (Díez-Palomar, 2015).

The benefits of these educational technologies are related to the fact that they can simulate real-world phenomena easily, favoring a learning mode that is more closely connected to students' personal lives (Spires, 2011). It has also been shown that the use of these educational technologies produces a positive effect on students' learning because they involve students in an intrinsically motivating learning setting (Papa Stergiou, 2009), (Foster, 2008).

Although now quite common, game-based learning technologies are currently applied mainly in the field of STEM education, a curriculum based on the idea of educating students in four specific disciplines like science, technology, engineering and mathematics with an interdisciplinary and applied approach (Meluso, 2012).

Different of other games and gamification

A game-based learning is about crafting the content around game-story. The students may create their own games or play other commercial video games. On the other hand, gamification is about shaping the game around educational context. Gamification operates on the assumption that the engagement experienced by the gamer should be translated to the learning context. This would eventually influence the behavior of student while facilitating learning at the same time. Since gamers willfully spend hours on solving the gaming challenges, the developers are using the potential of video games to harness learners' motivation and to apply the techniques to learning environments. Moreover, now instructional designers use a lot of more richer game elements and incorporate them in learning. These elements increase the motivation in learners. Also, it helps in drawing their attention and to engage them in learning through play as well as continuing playing as one of the major achievements (Racoon Gang, 2018).

Gamification fundamental concepts

There are some terms and concepts that have similarities in gamification, game inspired design, serious games, simulations and games. The boundaries between them are not clearly defined. Game inspired design is the use of ideas and ways of thinking that are inherent in games. Game inspired design does not express in adding game elements, but rather in using of playful design. Gamification is the use of game metaphors, game elements and ideas in a context different from that of the games in order to increase motivation and commitment, and to influence user behavior (Marczewski, 2013).

Serious games are games designed for a specific purpose related to training, not just for fun. They possess all game elements, they look like games, but their objective is to achieve something that is predetermined. Simulations are like serious games, but they simulate real-world things and their purpose is user training in an environment resembling real life. This also help to stimulates interest and attention towards learning. Thus, students will be more interested in studying because it is fun (Kiryakova, Angelova, & Yordanova, 2014).

History of gamification

Gamification refers to the application of game dynamics, mechanics, and frameworks into non-game settings. The concept of Gamification has been around for more than 100 years. However, with recent improvements and advancements in technology as well as increased interest in Constructivist approaches to education, gamification has recently become an interest to educators. Look at the list below that outlines the history of Gamification with some significant contributions dating back to 1896. Nearly 20 years before the Model T was introduced, marketers were experimenting with ways to inspire loyalty in their customers. Over 100 years later, brands are still searching for methods to positively reinforce buying behavior and engagement, with gamification producing unprecedented results. Gamification draws from an eclectic range of sources, but this timeline specifically explores the relationship between loyalty, games and fun. (Kiryakova, Angelova, & Yordanova, 2014).

In 2010, Gamification became a popular term in 2010. This is mostly due to the increase in interest from the Internet, an example being several videos from the DICE conference on gamification going viral, further increasing the knowledge of the term. In 2011, Inaugural gamification summit held in San Francisco attracted nearly 400 attendees. Oxford Dictionary added gamification to its word of the year shortlist – defines gamification as ‘the application of concepts and techniques from games to other areas of activity’. Gartner began to track Gamification on its technology ‘Hype Cycle’. Corporate gamification takes off. The success of gamified applications like Foursquare inspires many large corporates to jump on the gamification bandwagon. In 2011, global revenue from gamification marketing, software, and consulting reaches nearly \$100 million, according to M2 Research. In 2012, more organizations are experimenting with the techniques, but opinion is still largely divided over its effectiveness. This feeling of experimentation and failure can be summarized by Gartner who says that by 2014, 80 per cent of current gamified applications will fail to meet business objectives primarily due to poor design. In August 2012 Coursera launched a Massive Open online Course (MOOC) on gamification. The course attracted over 80,000 registered students. In 2013/2014, Coursera repeats its gamification MOOC, attracting 66,000 students in 2013 and 70,000 registration for its January course. M2 Research predicts that Gamification will be a \$2.8 billion industry by 2016 (Smith, 2014).

METHODOLOGY

This research uses quantitative methodology apply descriptive statistics using survey method to determine the problems faced by students in learning additional mathematics. A questionnaire with two sections; a close-ended section using Likert scaling with 1 being “strongly DISAGREE” and 5 being “strongly AGREE”, and an open-ended section with 3 subjective items is developed and distributed to respondents. Table 1 shows the list of the items in the questionnaire. Cronbach alpha for the questionnaire is valued at 0.79 which shows that it is suitable to be used in the study.

118 Muslim gifted and talented students of GENIUS Insan College were chosen as respondents for the questionnaire. The respondents are of age 15 (n=40), 16 (n=35) and 17 (n=28), with 60 being males, and 58 being females They are identified to have learned additional mathematics curriculum for form 4 in the standard national secondary high school syllabus. The data were inferentially and descriptively analysed using Microsoft Excel.

Table 1: Questionnaire Items

NUMBER	ITEMS
OPEN-ENDED ITEMS	
Q1	I am not interested in additional mathematics subject.
Q2	I consider additional mathematics as a difficult subject.
Q3	I rarely do additional mathematics’ exercise in my free time.
Q4	I cannot understand most concepts in additional mathematics’ syllabus.
Q5	I feel stressed while attempting to solve an additional mathematics’ problem.
Q6	I have not been able to achieve good grades for additional mathematics’ subject.
Q7	I think modern mathematics subject is much easier for me than additional mathematics subject.
Q8	I am not able to solve any questions that require High Order Thinking Skills (HOTS) in additional mathematics.
Q9	Trying to solve additional mathematics’ problems is my worst fear.
Q10	Learning additional mathematics subject is not important for me especially for my future.
CLOSE-ENDED ITEMS	
A1	What type of issue do you encounter when solving any type of additional mathematics’ problem?
A2	Do you consider learning additional mathematics as a burden for you? Why?
A3	Are there any suggestions you would share in improving the learning of the subject of additional mathematics?

MAIN RESULTS

Descriptive statistics of data collected

The problems of students with additional mathematics were surveyed through the results of a questionnaire conducted.

Table 2: Mean and Standard Deviation Table of Close-Ended Questionnaire Items

n = 118	
ITEMS	M (SD)
Q1	2.30 (1.11)
Q2	3.58 (1.05)
Q3	3.37 (1.10)
Q4	2.75 (0.96)
Q5	3.20 (1.14)
Q6	3.29 (1.34)
Q7	3.83 (1.18)
Q8	3.31 (1.09)
Q9	2.53 (1.23)
Q10	2.03 (1.16)

Table 2 shows the mean and standard deviation of each objective questionnaire items ranging from Q1 to Q10. High mean value generally is interpreted as a negative view on additional mathematics as a subject. Q7 has the highest mean value of 3.83 followed by Q2 (3.58) and Q3 (3.37). The lowest mean value obtained is for Q10 with 2.03. The average mean value of all items is 3.02, which in overall shows that moderate number of students have a slight level of problems with additional mathematics.

Table 3: Response Keywords Table of Close-Ended Questionnaire Items

ITEMS	RESPONSE KEYWORDS	NUMBER	PERCENTAGE
A1 - Type of issue encountered includes	Difficulty understanding concepts	61	51.7
	Complicated steps	84	71.2
	Carelessness	6	5.1
	Difficulty applying knowledge	14	11.9
	None	6	5.1
A2 - Does it perceived as a burden? Why?	Yes	44	37.3
	Difficulty understanding concepts	21	17.8
	Have no interest	6	5.1
	Bored	29	24.6
	No	74	62.7
	Easy to grasp	21	17.8
A3 - Suggestion to improve learning includes	Have interest	45	38.1
	Increase study drills	51	43.2
	Use an interactive style of learning	16	13.6
	Make session more interesting/ efficient in teaching	46	39.0
	Nothing	16	13.6

Subsequently, Table 3 disclose the response keywords of close-ended questionnaire items. The data observes that the type of issue encountered by students includes; difficulty understanding concepts with $n = 61$ (51.7%), needs complicated steps with $n = 84$ (71.2%), carelessness with $n = 6$ (5.1%), and difficulty applying knowledge with $n = 14$ (11.9%).

This is followed by the second item where 44 students (33.7%) was agreeing with the statement regarding perceiving additional mathematics as a burden, and 74 students (62.7%) are against the statement. Of the agreeing students, 6 (5.1%) have no interest while 29 (24.6%) stated being bored as a cause. Among the students disagreeing with the statement, 21 (17.8%) responded that the subject was easy to grasp and 45 (38.1%) shown that they have interest in the subject.

The third item opens to the suggestions of students, particularly, 51 students (43.2%) suggests increasing study drills while 46 students (39.0%) prefer to make session more interesting and 16 students (13.6%) responded with using an interactive style of learning to aid learning process.

Design of Game Kit

The game kit is designed as a card game that consist of different types as shown in Figure 1. It uses a turn-based gameplay that is described as in Flowchart 1. It used a merit-based scoring system with a ranking for each class of points obtained from solving a question correctly using combination of the cards to form an equation or a value as the answer.

The game kit is designed in the form of a card game with general rules as follow;

1) There 5 categorical cards include:

- i. Question cards
- ii. Alphabetical cards
- iii. Numerical cards
- iv. Operational cards
- v. Hint cards

2) 5 achievable ranks include:

- i. Genius New-born (range: 0-9 score)
- ii. Hardworking Student (range: 10-19 score)
- iii. Novice Mathematician (range: 20-29 score)
- iv. Master of Mathematics (range: 30-39 score)
- v. Professional Mathematician (range: 40-50 score)

3) Each player will be required to answer the given question correctly and saves up a total of scores at once and able to achieve any higher ranks. Any player able to achieve the highest rank in a given time will be the champion for that round.

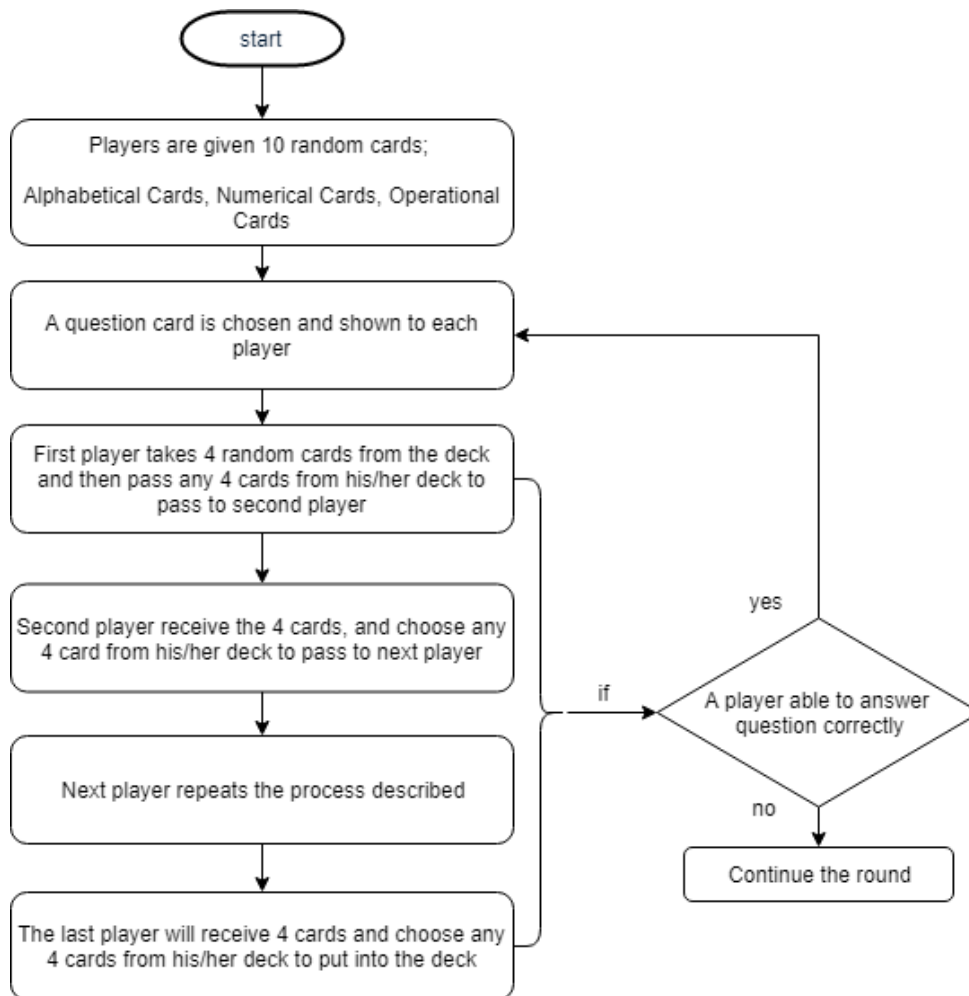
4) It is playable with 4-5 players.

5) The players are expected to have started learning additional Mathematic as a subject in Form 4 of secondary school system.

Figure 1 – Design of each type of cards



Flowchart 1 – Flow of gameplay



DISCUSSIONS

The result of this study indicates the existence of problems of students with the teaching of the subject of additional mathematics. It shows that moderate number of students identify certain complexities when dealing with the learning of additional mathematics based on the close-ended questionnaire such as fear of doing additional mathematics, not seeing additional mathematics as important, and the inability to tackle Higher Order Thinking Skills (HOTS) type of questions. The findings are supported by the findings of Mohd Rameli, Mohd Rustam. (2016) that states that negative perception towards mathematics such as perceiving mathematics as being too difficult and very confusing to learn will tend to make them quickly lose their interests and motivation to learn the course thus greater reducing their aptitude in the subject. This indicates the existence in the unsuitability of today's teaching method that causes students to deviate themselves further from having interest in additional mathematics, thus decreasing their performance in the subject.

Subsequently, the findings from the open-ended questionnaires further details the issues faced by students in additional mathematics where majority of students states that difficulty applying concepts and inability to make sense of tedious calculations steps as a challenge in learning process. Students are also shown to have certain level of negative perspective when the subject of additional mathematics is mentioned. This is in line with a study by Tambychik et al, (2010) that most students struggling with mathematics failed to organize the information and to construct mathematical sentences which were important in the process of problem solving.

The gamification of the learning process by the game kit designed used a merit based and ranking system gameplay, which are to attract students' interest and keep them from being bored. Kiryakova et al, (2014) discussed that few key components of a gamification process in education includes ranking of users according to their achievements and badges that represents scores.

This is to take advantages of students who will strive harder when put in a healthy competition against their peers. The game kit serves as an alternative medium that integrates interactive learning into students' classroom. However further studies are needed to identify the effectiveness of the game kit in aiding the learning process in an additional mathematics classroom.

CONCLUSION

As a conclusion, gamification in education provides an alternative route from the conventional learning process and simultaneously introduce the concept of interactive learning into the additional mathematics classroom environment. The methodology applied in the study are focused on exposing the underlying perspectives and thoughts of students towards the conventional learning process of additional mathematics in classroom. This study was conducted to obtain the problems experienced by students in the subject of additional mathematics and to design a solution to the problem. The key findings of the study include that moderate number of students from the sample population experiences certain level of difficulty with additional mathematics as a subject. Therefore, it is seen that the game kit designed is relevant to be applied in the classroom to overcome this problem in the learning process.

It is hoped that the findings provide insight and further impacts the community in applying innovations to counter the increasing issue of students in education. The key findings are able to give an overall view on the landscape of students' perspective on the current approach of the learning process of additional mathematics in the educational sector. The researcher suggests further research on the effectiveness of the game kit especially to students that are identified to be struggling in additional mathematics. Further studies are also needed to qualitatively describe the behaviour of students in approaching additional mathematics as a subject.

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