

Meaningful Gamification: A Conceptual Model of Discrete Math in a Flipped Classroom

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Abstract. Mathematics is embedded our lives in many ways. However, mathematics is often challenging for adult learners to master. The purpose of this paper is to provide a better understanding, especially on gamification features which can be applied in a flipped mathematic classroom. In doing this, a list of gamification features and content of learning based on Kevin Werbach's framework for gamification are identified. This study is expected to provide insights on integrating meaningful gamification features in a flipped mathematic classroom.

Keywords: Mathematics; gamification; Kevin Werbach's framework.

INTRODUCTION

Mathematics is commonly embedded our lives in many ways. However, mathematics is often challenging for learners to master as demonstrated by the TIMMS 2011 report. The report revealed a plummeting trend in the position of Malaysia in the Mathematics subject. Malaysia's ranked fell from 16th (1999) to 10th (2003), 20th (2007) and 26th (2011). Thus, empowering adult learners to learn mathematics, especially when they have encountered low mathematical performance in their past and the only reason to undertake the subject is because it is a prerequisite for obtaining a degree or diploma can be very difficult.

THE INFLUENCE OF LEARNERS' DIFFICULTIES IN MATHEMATICS

Students' preceding negative experiences in learning mathematics could discourage them from choosing careers in STEM (Science, Technology, Engineering, and Mathematics) fields (Petrillo, 2016; Ogden, 2015). In addition, Petrillo (2016) mentioned that more than 40% of engineering students in some universities eventually leave their disciplines mostly because of their underperformance in mathematics courses. In the same stance, 70% of the U.S. college students taking remedial mathematics failed their course and thus could not continue their studies (Weng, 2015).

Difficulty in understanding and retrieving concepts, formula, facts and procedure are among the reasons as to why learners in Malaysia find mathematics difficult (Zahrah, Jamaliah, Rohana, Badariah & Jaafar, 2003). They also lack the ability to visualize mathematical problems and concepts (Tarzimah, 2005). In order to succeed in today's challenging world, the learners require the "21st century skills". Lecturers face the challenge to start shifting from the 20th to 21st century classroom. As such, there is a need to improve the teaching and learning of mathematics.

MATHEMATICS & FLIPPED CLASSROOM

The advancements of technology added to the growing interest in the flipped classroom approach to mathematics education. Naccarato & Karakok (2015) highlights that this technology-enhanced pedagogy is now frequently used in many undergraduate mathematics and statistics courses. Basically, in a flipped classroom, the lecturers used instructional videos or other multimedia learning materials to deliver lectures before class meetings (Bishop & Verleger, 2013; Lo & Hew, 2017). Therefore, the in-class time is then liberated from instructor-centered teaching and can be spent on student-centered learning activities such as collaborative problem solving with the instructor's guidance (Bishop & Verleger, 2013; Giannakos, Krogstie, & Chrisochoides, 2014; O'Flaherty & Phillips, 2015). This pedagogical approach puts more responsibility for learning on the students so students can work towards mastery of the material.

MEANINGFUL GAMIFICATION

Gamification refers to the use of various elements from games in non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011). Gamification has proven to be effective in education as it increased determination and students engagement on tasks like learning. Moreover, students enjoyed themselves during the task. It also can be used as a tool to motivate students and increase their engagement as they need motivation to study and exchange ideas (Elshiekh & Butgerit, 2017).

If the flipped classroom puts forward the learning responsibility on the student then gamification highlights the ability to give feedback to learners. This is the main reason why gamification feedback should be meaningful. This means that the feedback should be able to help learners know how they are doing in class.

Nowadays, university students are more exposed to gadgets and games and they are most likely are motivated to learn through them. This is proved by a research done by Kasurinen and Knutas (2018) where they suggested the latest approach to engage students for learning in education domain is through gamification. However, the studies also mentioned that designing features for the game needs more attention because it is not easy to do.

This study aims to propose a conceptual model of embedding gamification based on Kevin Werbach's framework to a discrete mathematic flipped classroom. Hence, the problem statement of this research is "What are the gamification features that can be applied in a discrete maths flipped classroom?"

RESEARCH METHODOLOGY

Our approach is based on Kevin Werbach's framework for gamification. According to Werbach's framework, before any gamified application is created, the development must be approached with a game design-like thinking (Werbach, 2012). Only then is it possible to see which of these elements contribute and add extra value to the user experience and which of them do not. Werbach (2014) has categorized these elements as follows:

1. Define objectives
2. Delineate target behaviours
3. Describe your players
4. Devise activity loops
5. Don't forget the fun!
6. Deploy the appropriate tools

Table 1 shows the steps in the framework:

TABLE (1). The Steps in the Framework.

Elements	Description
Define objectives	Study the nature of discrete math learning objective
Delineate target behaviours	Identify gamification elements that suitable to be applied in the learning courseware (literature review)
Describe your players	understand what sorts of game elements and other structures are likely to be effective for this population (interviews)
Devise activity loops	Identify motivation for students engagement and progression loops (feedback mechanism)
Don't forget the fun!	Check to ensure that your gamified system is fun(questionnaire)
Deploy the appropriate tools	Test and evaluate with numerous platform

FINDING AND DISCUSSION

Several problems in discrete math is derived from the students' insight while describing the players. The interviews were conducted with ten students who have been introduced and learned with discrete maths topic. They were asked about their problems in learning this topic during their studies. As a result, five major problems have been identified, as follows:

1. Does not really understand the concept.
2. Have problem in memorizing the concept.
3. Do not know how to apply calculations to real life problem.
4. Easy to lose focus in class.
5. Did not get instant feedback from lecturer for assignment.

These problems occurred consistently among the ten students who have been interviewed. To encounter the learning problems, the researchers then match the listed problems with its nature of discrete math together with its appropriate gamification features. Table 2 shows the selection of gamification features based on problems and nature of discrete math.

TABLE (2). The Selection of Gamification Features Based on Problems and Nature of Discrete Math.

Problems in learning discrete math	Solution	Gamification Features
P1. Does not really understand the concept	Must make them understand the concept clearly	Narrative, Storytelling
P2. Have problem in memorizing the concept.	Help them to memorize the concept.	Narrative, Storytelling
P3. Do not know how to apply calculations to real life problem.	Teach them the steps of calculations using real life scenarios	Levels, Hint, Challenges
P4. Easy to lose focus in class.	Make the students compete for each other	Point, Achievements, Leaderboard
P5. Did not get instant feedback from lecturer for assignment	Provide instant feedback	Feedback

The gamification features chosen to solve P1 and P2 is narrative and storytelling. This is because P1 and P2 are both theoretical problem. Narrative is a storyline in a game and it provides a context for learning and problem solving as well as helps to illustrate the applicability of concepts to real-life (O'Donovan, Gain, & Marais, 2013).

P3 involves integrating both theory and practical knowledge. Therefore, the relationship between both discrete maths and real-life usage need to be considered. Calculation steps will

be gamified into level because it is the most suitable game elements for it. This is because according to Crumlish & Malone (2009), levels represent evidence of the whole progress. Consequently, the levels and challenges can be viewed as learning objectives for learners. Thus, if a user is faced with the same challenge, just at a higher difficulty level they might soon lose interest (O'Donovan et al., 2013).

In order to encounter P4, experience point and leaderboard are implemented. A leaderboard shows which users are leading in the gamified activities. Leaderboard can trigger competition between students in the class (Wood & Reiners, 2012). Using experience points is even more attractive than giving the students a grade (Deterding et al. (2011). It provides direct feedback on how successful students are being and also serve as instant gratification, which was previously shown to be successful in motivating college students (Natvig, Line, & Djupdal, 2004).

Instant feedback will be used to encounter P5 as it is important as it give students chance to improve what they did not understand. Feedback is an information of user's performance in the game and it can be used for improvement. Students might already forget about what they did not understand in previous class, therefore, an instant feedback from lecturer is needed to make sure students can understand it faster.

CONCLUSION

The proposed model will encourage students to learn and play at the same time. Since the students are not forced in the learning process, therefore the learning process will happen willingly. The discrete math concept and problems in learning on this topic are combined together and matched with gamification features to produce a game that can provide an enjoyable learning experience and also exciting game play.

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