DEVELOPING A GAMIFICATION FRAMEWORK TO IMPROVE DISCRETE MATHEMATICS IN A FLIPPED CLASSROOM: A WORK IN PROGRESS

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ABSTRACT

In education, there is an existing problem about how to relate concepts learned in mathematics. The purpose of this paper is to provide a better understanding on gamification features which can be applied in mathematics flipped classroom environment. This paper is part of an on-going project to develop a gamification framework for flipped classroom. This study is expected to provide insights on successfully finding the gamification features that build the initial framework later on.

Keywords: Discrete mathematics; gamification; flipped classroom.

1.0 BACKGROUND OF THE STUDY

The world of the 21st century is experiencing a unique rate of change. The ability to anticipate and adapt to these changes is the only way for individuals to guarantee their continued success and to remain competitive. According to Hansen and Leuty (2012), the term generation typically refers to a group of individuals who share common life experiences or work experiences. The unique life experiences introduced during their developmental years inevitably contributed to the values of the learners of each generational cohort. Current discussions point to the presence of two distinct generations that are either entering the job market or entering higher education learning today: Generation Y (Millennials) and Generation Z (Post-Millennials). Generation Y refers to people who were born between 1980 and 1995 (Knight 2014) while Generation Z are those people born between 1995 and 2010. According to Eastman, Iyer, Liao-Troth, Williams, and Griffin, these millennials are "enthusiastic about technological advances".

Oddly, according to Goodman, Sands, and Coley, although millennials in the USA have superior education levels as compared to previous generations of workers or learners, they have less competences, when compared to other countries (literacy and when dealing with numbers) as well as less capacity to solve problems in rich technological environments (Goodman, Sands, and Coley, 2015). Similar problem is also obvious in Malaysia as for these millennials, mathematics is known as a challenging subject. The proving comes in the form of the TIMMS 2011 report. The report revealed a decreasing in the position of Malaysia in the Mathematics subject. Malaysia's ranked fell from 16th (1999) to 10th (2003), 20th (2007) and 26th (2011). This comes as a surprise because despite the millennials having grown up with and being usual users of information and communication technologies, they lack soft skills to be used especially in increasing their capacity to visualize mathematical problems and concepts (Tarzimah, 2005).

The problem arises because these millennials do not feel that they are as good in real life situations as they are in games. When met with difficulties, these millennials may feel depressed, devastated, discouraged or even cynical. These same feelings are not present in the gaming environment. In addition, these millennials also prefer immediate pleasure to keep themselves engaged and motivated. Thus, allowing gamification to step in. Gamification refers to the use of various elements from games in non-game contexts (Deterding, Dixon,

Khaled, & Nacke, 2011). The gamification concept starts with a designer who takes the motivational properties of games and layers them on top of other learning activities, integrating the human desire to communicate and share accomplishment with goal-setting to direct the attention of learners and motivate (Landers & Callan, 2011, p. 421).

Gamification has become a popular approach to encourage and influence specific behaviours in the millennials, to increase motivation and engagement. Even though a majority of gamification is commonly found in marketing strategies, it is now being applied in many educational programs as well (Huang & Soman, 2013). Gamification helps to motivate students towards studying because of the positive feedback in the gamification. Due to this reason, the students are encouraged, show more interest and are inspired to learn. Muntean (2011) iterates that gamification constitutes a powerful boost to make students determined to study or read more. Therefore, by using gamification, the study wishes to find the framework that trigger a more efficient and engaging learning behaviour among discrete mathematics learners.

2.0 STATEMENT OF THE PROBLEM

Gamification draws inspiration and momentum from sources not often associated with serious pedagogy (Educause, 2011). However, the literature on gamification indicates that the technical expertise to create high-end gamification experiences serves a barrier for adoption (NMC, 2013). In addition, several studies have also pointed out issues with the depth of learning achieved through the application of gamification principles and have questioned the transfer of the primarily extrinsic rewards associated with gamification to deeper, intrinsic understandings (Donston-Miller, 2012; Dominguez, Saenz-de-Navarrete, de-Marcos, Fernandez-Sanz, Pages, & Martínez-Herráiz, 2013). From the learners' point of view, not much research has been performed about how to teach millennials, what they expect from higher education, and what they think of leadership and ingredients to success (Lourenco and Cronan, 2017). Therefore, the ever growing popularity of gamification for millennials coupled with the mixed success reported from both industry and teaching provides a reasonable cause to further explore the specific processes by which gamification is intended to improve learning (Landers, Bauer, Callan, & Armstrong, 2015) as proposed by this study.

2.1 Objectives of the Study

The study is done:

i. To analyse the teaching and learning environment at the selected higher education institution and introduce the gamification concept.

Thus, as an initial part of the ongoing process, this study reports on the findings of the following question: Does gamification helps to increase the teaching and learning of discrete mathematics in a flipped classroom?

3.0 LITERATURE REVIEW

3.1 Motivational Theories to Understand Gamification

Motivation is an internal drive. Motivation plays an important role especially when interacting with a digital system (Jung, Schneider, & Valacich, 2010). Nevertheless, Wyeth, Johnson, & Sweetser (2012) claimed that the experience of being entertained through games is not yet well understood especially from a psychological perspective. In addition, an article by Sinha (2012) in Huffington Post also argued that most learners lose their enthusiasm in learning due to the inadequately designed motivation scheme utilized in educational tools.

Motivation is divided into two camps – intrinsic and extrinsic (Ryan & Deci, 2000). In simple terms, intrinsic motivation is an innate drive to do something. While extrinsic motivation pushes you to do something because of an external reward or punishment. Among the available gamification theories discussed are; from the perspective of Maslow's hierarchy of needs theory, Skinner's reinforcement theory and the flow theory.

Maslow's hierarchy of needs is a suitable model to examine before mapping game principles to motivational theory. Maslow recommended that individuals have a hierarchy of needs and that each need must be addressed to become self-actualized. The four lower levels (lower-order needs) are considered physiological needs, while the top level of the pyramid is considered growth needs (refer to Figure 1).

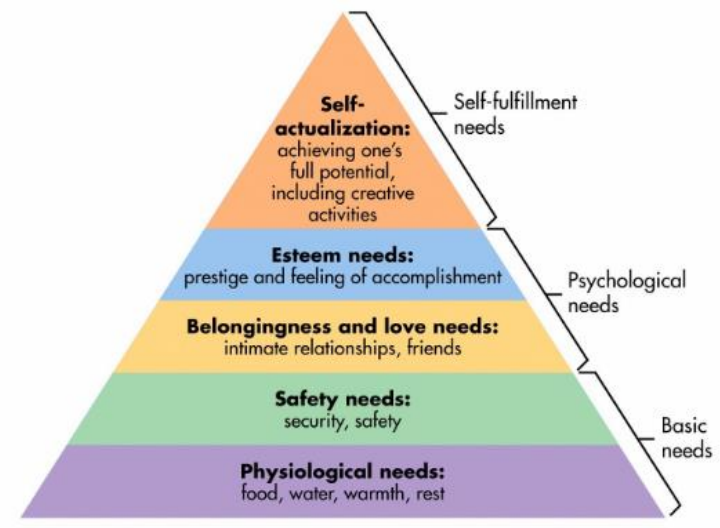

Figure 1: Maslow's Hierarchy of Needs Theory
(Source: http://simplypsychology.com)

The Maslow's theory outlines about what learners need, and these needs are what motivate learners. Therefore, in order for gamification to work, lecturers need to first consider the learners' needs as this is the source of their motivation.

Skinner's Reinforcement Theory is a model which claims that human behaviour is a result of the growing effects of environmental reinforcements and learning. According to the reinforcement theory (Skinner, 1976), the change in the learners' attitudes and behaviours is learned by operant conditioning, where the consequences of humans' actions modify the tendency to repeat a behaviour. Skinner's theory is different from the Maslow's theory as the former disregards innate needs and uses only external conditions/reinforcement to manipulate and shape people's behaviour. As such, the theory posits that conditioned reinforcements are learned, and they become the motivator. As such, gamified learning environment should be designed with sufficient game mechanics and game dynamics to condition the learners along their learning process.

The Flow Theory is a theory developed by Csikszentmihalyi in 1975. Flow is an optimal state of intrinsic motivation, where learners become totally immersed in what they are doing. Learners experiencing flow often forget about physical feelings, the passing of time, and diminish their ego. Most learners love to be in the control state, because it gives them a sense of security and safety. But equivalently, they also hate boredom. However, in time, as learners acquire skills, they unconsciously move into the boredom state. Thus,

learners require some kind of new challenging tasks on timely basis. In the stance, the flow theory is thus the theory that balances between the two previous theories. Recklessly giving learners points is not going to work over the long term, because this resulted in learners getting tired and bored rather quickly.

3.2 The Building Blocks of Gamification

The two basic building blocks in gamification are the game mechanics and the game dynamics. They are interrelated and used interchangeably. This study adopts the definition by Grünberg where game mechanics are the agents, objects, elements and their relationships in the game. In the book "Ten Ingredients of Great Games", authors (Reeves & Read, 2009) identified ten game mechanics elements: (i) Self representation with avatars; (ii) three-dimensional environments; (iii) narrative context; (iv) feedback; (v) reputations, ranks, and levels; (vi) marketplaces and economies; (vii) competition under rules that are explicit and enforced; (viii) teams; (ix) parallel communication systems that can be easily configured; (x) time pressure. While, game dynamics is the result of the exciting and motivational nature of the experience in using game. There are numerous game dynamics elements such as rewards, status, competition, self-expression and others (Schonfeld, 2010). The following table shows a list of popular game mechanics elements and with their descriptions. These elements are typically used in combination.

Table 1: Popular Game Mechanics Elements
(Adapted from Kankanhalli, Taher, Cavusoglu, & Kim, 2012)

Game Mechanics	Description
Points	Users can earn different types of points by participation and performance.
Levels & Status	Level typically shows progress in the game. Level may be indicated by a numeric value or a user's status such as "novice" or "expert.
Quests & Challenges	Quests and challenges guide users to perform pre-defined tasks. They help inexperienced users to learn how to move forward.
Badges & Achievements	Users can collect badges that visually indicate their achievements as they accomplish specific tasks and missions.
Leaderboards	A leader board enables users to compare their own performance with others and stimulates competition
Progression	A visual tool that displays the advancement of users and the remaining work to reach a goal. It motivates users to accomplish a pre-determined goal.

4.0 RESEARCH METHODOLOGY

4.1 Samplings

The purposive sampling technique was also used to select 15 students from three accessible populations of 60 students from three different institutions selected for the study. Each institution has 20 students respectively. This purposive sampling technique was adopted because the students at the institutions exhibit almost similar characteristics of interest to the study which is having taken at least one flipped learning classroom and have experience in playing video or Internet game.

4.2 Data Collection Instruments

Considering the nature of research questions that were being examined, the instruments used for the collection of data were observation and a semi-structured interview. These instruments were used to offset the weaknesses of each other.

5.0 RESULTS

Observation was used to identify and analyse how teaching and learning of discrete mathematics was being done in terms of whether there were game elements present in the process before the introduction of gamification; and how game elements were used in the classroom after the introduction of gamification. The results of the observation will not be discussed in this paper.

The interview was conducted in two phases: pre-interview and actual interview. Pre-interview was conducted to determine the suitability of the instrument; whereas the actual interview was conducted after the pitfalls of the pre-interview was corrected by the researcher. For this reason, one student was selected to be initially interviewed. The interview was conducted mainly to assess how the teaching of discrete mathematics is done and the effect the teaching has on the learners. The interview time frame for students was between 20-25 minutes.

The interview and observation sought data on evaluating all the game elements used in the classroom and the effects they had on learning of mathematics. The evaluation data are discussed in this section.

All the responses were in the favourable that they were aware of the gamification potential and ability to help them in their learning. The responses from majority of the pupils were similar in term of that. To the question "Do you think that the use of gamification during online learning can help increase your technical competencies?" a majority of the interviewees pointed out that their technical skills increased during the progress of the lessons with gamification. Some of the students added these further comments:

"it is like practical learning"
"can create your emotion to learn"
"it easier to remember and can practice what i have learnt."
"gamification help my strategy skills"

To the question "Why do you think that the use of gamification during online learning help create an interesting/enjoyable learning environment?" a majority of the interviewees agreed that gamification create a more enjoyable learning environment. Some of the students added these further comments:

"Less stress"
"Everybody enjoys less stressful environment with the use of gamification"
"Because it not like reading books"
"student will create their own ideas"
"because it create emotion"
"because gamification is fun as it will too develop strategy skills."
"it sometimes release our tension."

It was realised that all the interviewees were in agreement that the gamification tools deployed to the mathematics lessons in a flipped online classroom help them in some way or another.

6.0 CONCLUSION

This study is one of the few attempts to investigate the ability of gamification to improve the teaching and learning process of discrete mathematics in a flipped classroom. The findings showed preference towards using gamification. The findings also contributed towards determining the proposed framework to be used when implementing gamification in a flipped classroom.

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