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Perception, Motivation and Performance of Students in Food Preservation Technology Course Through Game-Based and Gamification Approach

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Abstract: Interactive learning that involves students participation and cooperation has been reported to help develop creativity, problem-solving and critical thinking skills, which are among top ten skills needed in 2020. The incorporation of game-based and gamification in teaching and learning is an interesting approach to enhance students learning abilities and skills acquisition through fun and immersive learning experience. This study aims to examine the implications of game-based and gamification of learning towards students perception, motivation and performance in engineering students particularly for those who attended the Food Preservation Technology course. Positive improvements were seen through the implementation of the game-based and gamification of learning. Findings show that game-based and gamification prepared students with better grasp and retention of knowledge, hence they achieved better grades at the end of the semester compared to students that involved in traditional classroom teaching method. Game-based and gamification can add variety and change of pace to classes subsequently developed interest in both students and instructors towards the course.

Keywords: *Classroom Approach, Engineering Education, Game-Based Learning, Gamification, Skills Enhancement*

INTRODUCTION

Traditional lecture-based teaching where teachers transfer knowledge to students is a one way communication in classroom approach. In traditional teaching approaches, students are forced to learn and acquire information during class session. Thus, this might trigger boredom for some students due to the variety of the students' learning pace. Fully understanding information and applying knowledge in new situations or in assignments are more difficult. In these situations, the presence of a teacher is crucial, because teachers can support critical thinking and show students how to solve problems (Anderson et al., 2001).

Interactive learning that involves students actively and cooperatively has been reported to help develop creativity, problem-solving and critical thinking skills, which are among top ten skills needed in 2020. The incorporation of game-based and gamification in teaching and learning is an interesting approach to enhance students learning abilities and skills acquisition through fun and immersive learning experience. Positive improvements in students motivation, engagement and performance in the Chemical Engineering courses may also be developed through the implementation of the gamification of learning. Game-based and gamification can add variety and change of pace to classes and make the course more interesting for both students and instructors.

In the alternative classroom model where game-based and gamification are introduced, students acquire foundational knowledge prior to face-to-face classroom through watching videos or web-lectures and reading books (Bouwmeester et al., 2016), before deepening and applying this knowledge during in-class gamification module such as analyzing case studies and undertaking collaborative group work (Bouwmeester et al, 2019).

1.1 Effects of game-based and gamification in learning

Games have been shown to be effective in promoting learning (Annetta, Minogue, Holmes, & Cheng, 2009; Barab et al., 2005; Ke, 2008; de Freitas, 2010; Liu et al., 2014; Papastergiou, 2009), and are more motivational for students than non-gaming teaching methods (Barab et al., 2005; Papastergiou, 2009). Games have been shown to

be effective for learning “partly because learning takes place within a meaningful context”

(Van Eck, 2006), which allows for application and practice. Effective games must be “motivating, addictive, and provide encouragement through very short-term goals, so that the player can fail and try again until they succeed.

1.2 The role of student motivation

Gamification’s impact on student motivation and performance is an important topic, as there has been increased interest in gamification (Hanus & Fox, 2015) at the college level. Many universities and colleges have shown interests to incorporate gamification into their curriculum to better reach mobile-savvy students and increase student engagement. Other than game-based learning, using gamification elements (e.g., goals, rules, and feedback systems) to engage students may have impact in improving their literacy skills.

1.3 Game-based and gamification activities

Gamification is related, but not identical, to the concept of game-based learning. Gamification is about the use of game design elements in a non-game context, while game-based learning refers to the use of actual games to acquire skills or knowledge. In game-based learning, the skills that are put to the test in the game correspond to the learning task (Gee, 2013), as is for instance the case in a game where medical students or personnel perform surgical procedures in a simulated environment (Kapp, 2012). Typically, gamification includes the incorporation of game elements such as points, leaderboards, and badges (Barata, Gama, Jorge & Goncalves, 2013; Mekler et al., 2013b), or avatars, three-dimensional environments, feedback, ranks, levels, competition, communication systems, and time pressures (Deterding et al., 2011).

1.4 Concerns regarding game-based and gamification in learning

Not all research reported a positive relationship between the

incorporation of game-based and gamification in learning and student motivation and performance. A small percentage (10%) of studies reported no impact or negative impacts on student motivation (Berkling & Thomas, 2013; Hanus & Fox, 2015). Additionally, some studies reported mixed results with respect to motivation (Dominguez et al., 2013; Haaranen et al., 2014; Meyer, 2008). Meyer (2008) indicated that students reported that gamification did not affect their motivation to post or quality of post in a discussion forum; however, a small percentage (15%) of students did report a positive impact as a result of the introduction of point-based rewards. Similarly, Dominguez et al. (2013) reported that 31% of students found gamified environments motivating; however, 62% of learners reported that the traditional activities were more motivating.

The impact on learning and student performance was difficult to ascertain, as many studies did not report the effects on student performance. Of studies reporting results related to academic performance, the results are mixed. Barata et al. (2013) determined there was an increase in the number of students attaining the highest grades, as well as a decrease in the difference between the lowest and highest student grades. This is consistent with the findings of Mekler et al. (2013b), who found that gamification “significantly increased performance.” Contrary to this finding, Hanus & Fox (2015) and de-Marcos et al. (2014) found that learners who participated in the gamified environment had lower exam scores, while Goehle (2013) found little evidence of impact either positive or negative on student performance.

1.5 Present study

The purpose of the current study is (1) to design the class activities incorporated with game-based and gamification, (2) to study the motivation of engineering student on game-based and gamification activities for learning, and (3) to determine the performance and retention of knowledge in game-based and gamification learning, all in comparison with traditional lecture-based education. We hypothesized that the engineering students participating in the Food Preservation Technology course of Universiti Teknologi MARA, Shah Alam,

Malaysia, were motivated and more engaged during game-based and gamification approach in classroom and online platform. The introduction of game-based and gamification in learning may also result in more in-depth discussions with peers and instructors during classroom sessions. As students are able to discuss on a more

advanced level, and provide more input during classroom discussions, students with game-based and gamification approach may equip themselves with higher soft skills and achieve higher grades. Moreover, since students are actively challenged to apply their knowledge during classroom sessions, it is also assumed that this knowledge will retain better, meaning that they may perform better on cognitively complex questions during the retention exam (Bouwmeester et al, 2019).

METHODS

2.1 Educational setting

This study was conducted in a Food Preservation Technology course, during two consecutive semesters. The course is an elective course as part of a 4-year Chemical Engineering program. The course was planned as a blended learning, amounting to 70 h per semester. In September 2018 – January 2019, the course was given in a traditional lecture-based design, where that students could attend lectures to acquire new knowledge. Some lessons were taught using online Learning Management System (LMS) via UiTM i-Learn, but still in a traditional lecture-based where slides and notes were provided and group discussion were done upon in online forum.

In March – July 2019, this course was mostly taught using the incorporation of game-based and gamification of learning. Students were asked to prepare before face-to-face classroom sessions, in particular by watching recorded videos and lectures, and reading text in the online LMS. The acquired knowledge was pre-requisite to participate actively during game-based and gamification class sessions in which assignments were to be solved particularly by involving themselves in games.

2.2 Participants

In March 2019, 33 students participated in this study. Students were on average 23.6 years old, and 51.5% were male. In September 2018, 36 students participated in this study. These students were 21.9 years of age, and 36.2% were male. The researchers did not retrieve any information about ethnicity or disability status of the students. Participation was voluntary and no incentives were given.

2.3 Data collection

During the course (September – December 2018 and March – June 2019), in-class observations were performed and students were invited to report their perception in a questionnaire survey. At the end of semester (July 2019), students indicated their perceived self-efficacy, a measure for competence, and filled out the anonymous course evaluation.

2.3.1 Perception and motivation of students

A questionnaire survey was given to the participants at the end of semester on their perception of game-based and gamification approach, and motivation on type of teaching methods used for classroom session. The teaching methods/activities include traditional lecture, group discussion, short quiz, student presentation, games, activity using technology, problem solving, research and guest lectures. Students were also asked to give comments on their perception of game-based and gamification for learning.

2.3.2 Performance of students

The performance of students was analysed based on these data:

- 1) Comparison of marks between Test 1 (game-based and gamification approach) and Test 2 (traditional lecture) for cohort September 2018.

- 2) Comparison of grade between cohort Sept 2018 and March 2019.
- 3) Comparison of perception vs performance on game-based and gamification in learning.

RESULTS AND DISCUSSION

3.1 Student perceptions and motivation of game-based and gamification in learning

Fig. 1 shows the motivation on type of teaching methods and learning activities for student from cohort September 2018 and March 2019. It can be seen that game-based and gamification approach gained the highest preference, 94.3% and 76.5% for cohort September 2018 and March 2019, respectively. The second highest preference was activity using technology which was not surprising as this mobile-savvy generation engaged with their gadgets most of the time. Not more than 30% were motivated by traditional lecture approach in classroom setting for both cohorts.

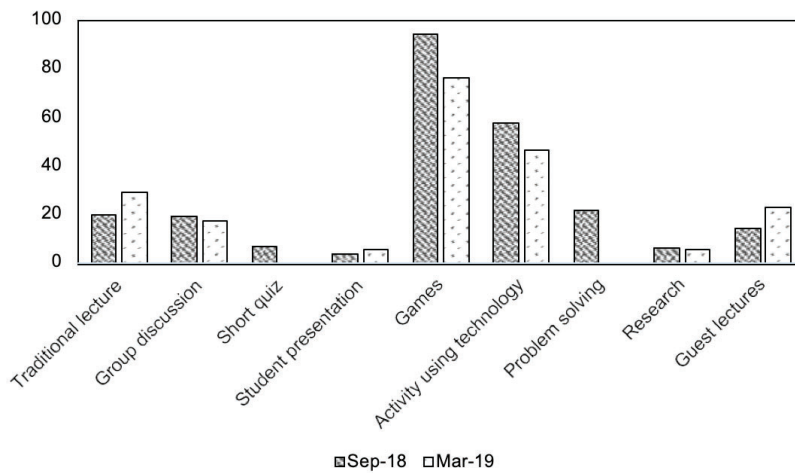


Fig. 1 Students preference on learning activities for cohort Sept 2018 and March 2019

3.2 Student performance in game-based/gamification compared to traditional lecture

Table 1 shows the median, average, minimum and maximum marks of Test 1 and Test 2 for students from cohort September 2018. Test 1 was done based on topics that were taught using the game-based and gamification approach, while Test 2 covered topics taught in traditional classroom lectures.

It was found that for all median, average, minimum and maximum data were higher for Test 1 (game-based approach) compared to Test 2 (traditional lecture). This shows that students performance were significantly influenced by teaching approach and game-based teaching model resulted in better marks for students.

Table 1. Comparison of Test 1 (game-based approach) and Test 2 (traditional lecture) marks for cohort Sept 2018

	Test 1	Test 2
Median	10.50	8.00
Average	10.53	8.57
Min	6.00	5.00
Max	14.25	14.00

Fig. 2 shows the percentage of students with their grades at the end of semester for cohort September 2018 and March 2019. Clearly, no student achieved the A grade for cohort September 2018 where there was traditional classroom teaching involved. It could be because the retention of knowledge was reduced because of the mix mode of teaching model. Meanwhile for cohort March 2019, around 24% of total students achieved the A grade and another 33% attained the A- grade. Both cohort shows around the same percentage (36%) for B grade.

This findings show that game-based and gamification prepared students with better grasp and retention of knowledge, hence they achieved better grades at the end of the semester compared to students that involved in traditional classroom teaching method.

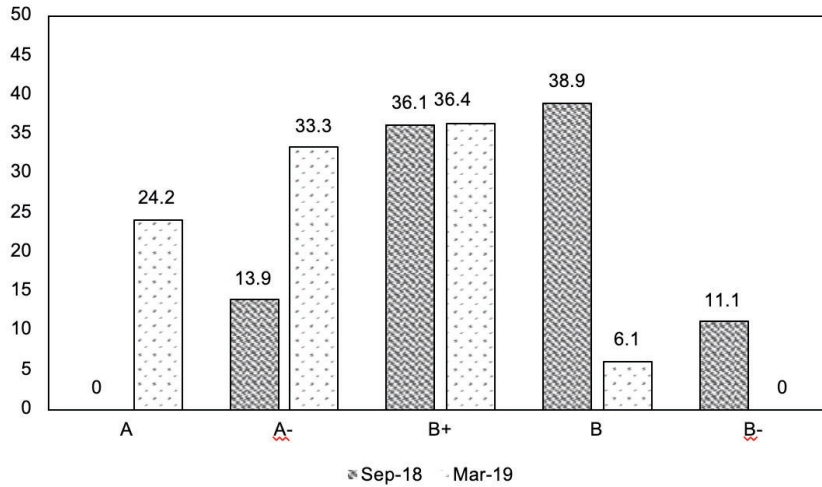


Fig. 2 Percentage of students according to grades for cohort Sept 2018 and March 2019

CONCLUSION

Game-based and gamification can add variety and change of pace to classes and make the course more interesting for both students and instructors. In terms of practical implications, educators who are about to implement the game-based and gamification approach should be well aware of the amount of time involved for both students and instructors. Students need to adapt their learning approach to benefit from the game-based and gamification model. It seems that this model has more obligations compared to conventional teaching approaches, as students need to be prepared for application of knowledge, either in the classroom or online platform. It is important that educators are able to stimulate students' self-motivation and engagement during the practical of game-based and gamification approach in classroom or online platform.

For instructors, it is known that preparation of out-of-class materials and getting acquainted with the interactive, and in-depth teaching method is time consuming (Moffett, 2015; Snowden, 2012). Once the learning materials are created, they can be re-used in other classes (Moffett, 2015; Wagner et al., 2013).

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