The development of gamified learning activities to increase student engagement in learning

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Abstract

In the literature, the potential efficacy of the gamification of education has been demonstrated. The aim of this study was to explore the influence of applying gamification techniques to increase student engagement in learning. The quasi-experimental nonequivalent-control group design was used with 577 undergraduate students from six classes. The students in three of the classes were assigned to be the treatment group whereas the students in the others were the control group. Students in the treatment group attended a course designed for gamification, while students in the control group attended a regular course. The results showed that in the treatment group, student engagement in learning was significantly better than that of the students in the control group. We provide empirical support for gamification of education and conclude that students clearly valued the engagement of gamified learning activities.

Keywords

Learning Activity, Gamification, Gamified Learning, Engagement

Introduction

Student engagement refers to the extent of a student's active involvement, the degree of attention, interest, and passion that students show when they take part in the learning process (Reeve, 2012; Trowler, 2010). Student engagement is one of most important factors associated with improved learning, and much of the research to date has indicated the importance of student engagement leading to a positive impact on learning outcomes (e.g. Carini, Kuh, & Klein, 2006; Klem & Connell, 2004; McMahon & Portelli, 2004). The more students are engaged in learning, the more they will learn and progress in their learning.

In contrast, disengagement had a negative impact on learning outcomes (Brint & Cantwell, 2012; Kaplan, Peck, & Kaplan, 1997; Liem, Lau, & Nie, 2008), which is not desired for educational purposes. In addition, educators find that a lack of student engagement is a primary problem which can create difficulties in effective learning (Heaslip, Donovan, & Cullen, 2014). Thus, how to promote student engagement is a significant challenge for educators.

In the literature, there have been many studies examining the predictors of student engagement (e.g. Cothran & Ennis, 2000; Fullarton, 2002; Hampden-Thompson & Bennett, 2013; Handelsman, Briggs, Sullivan, & Towler, 2005; McMahon & Portelli, 2004). They found that numerous factors influence student engagement, including institute culture and policies, the views of students themselves, individual competence of students, qualities of teaching or teachers, and learning activities. One of the teacher's fundamental tasks is to facilitate learning activities, which have a direct impact on student learning (Anaya, 1996; Beetham & Sharpe, 2007). Teachers are challenged to carefully design appropriate activities. Using 'serious' games in education has a lot of potential, since it is an effective tool for engaging students. Therefore, many teachers have considered integrating games into their learning activities. However, serious games are usually hard and expensive to build. There may be equipment costs, software costs, and there are often support- or maintenance-related costs for a system (Ib et al., 2014). Since 2010, gamification has been regarded as a new trend in which game mechanics and game dynamics are applied in a non-game context. It aims to improve people's experience, engagement, motivation, and to create a sense of playfulness (Reiners & Wood, 2014; Schönbohm & Urban, 2014).

In the literature, research on gamification has indicated that it is effective in terms of engaging and motivating people to drive behaviors and effect desired outcomes (Brigham, 2015; Caton & Greenhill, 2014; Cheong, Filippou, & Cheong, 2014; Leaning, 2015). There is a growing interest in using gamification in education; many educators have attempted to apply its concept to learning activities. Moreover, several studies have been conducted to show the potential of gamification in teaching and learning. Nevertheless, there is still a need for more studies that report the implications of applying gamification in learning environments (Borges, Durelli, Reis, & Isotani, 2014).

In order to fulfill the requirement of more studies on gamification in education, the present study was designed as a case study, in order to explore the influence of applying gamification techniques to increase student engagement in learning. Specifically, we designed gamified learning activities with a combination of online and offline learning activities, and then investigated a group of undergraduate students studying on a general education course. Previously, there have been studies which examined the individual differences in terms of motivational goal orientation (Gonida, Voulala, & Kiosseoglou, 2009; Poondej, Koul, & Sujivorakul, 2013), computer self-efficacy (Busch, 1995; Cassidy & Eachus, 2002), and perception of the classroom learning environment (R. B. Koul & Fisher, 2005). Therefore, these factors, which can influence student engagement, were considered covariance variables in the analysis.

My hypothesis was that gamified learning activities would increase the level of student engagement during the learning process. Based on our findings we have provided some recommendations for applying gamification to learning activities.

Background

Gamification of education

The broad use of the term 'gamification' started in 2010. In general, this term is widely accepted and used to refer to the use of game-based elements, such as game mechanics and game dynamics, in non-game contexts to improve people's experience, engagement, motivation, and to create a sense of playfulness (Burke, 2014; Reiners & Wood, 2014; Schönbohm & Urban, 2014). Game mechanics have some distinctive tools which play a key role in gamification. The points-scoring system, competition with others, award of rewards or badges for levels of achievement, and display of leaderboards are the specific elements used in gamification application.

A number of companies have started using gamification in various applications and processes such as: (1) Bunchball and Badgeville, which has provided game mechanics, reputation mechanics, and social mechanics as a service to motivate, engage, and generate loyalty among customers, partners and employees; (2) DevHub Site Stream, which has implemented gamification strategies on the website to increase consumer engagement; and (3) Foursquare, in which users get points for sharing their location on a social network (Ibanez, Di-Serio, & Delgado-Kloos, 2014).

Although the concept of gamification first led to great ideas for business strategies, it is currently receiving increasing interest from other areas, especially education. Gamification of education is the use of game-based elements in a learning environment. It is a new approach and has become a popular technique to enhance instructional outcomes in education. Most studies have demonstrated the usefulness of gamification in education, particularly in increasing students' motivation and engagement (e.g. Domínguez et al., 2013; Ibanez et al., 2014; Kim, 2013; Kuo & Chuang, 2016; O'Donovan, Gain, & Marais, 2013). Moreover, game elements used in gamification can make learning more fun and interesting for students (Barata, Gama, Jorge, & Gonçalves, 2013; Werbach & Hunter, 2012). Thus, due to the reasons for using gamification in education, it can be used as a potential learning process tool to enhance students' motivation and engagement, with the goal of improving the quality of learning.

Related work

There have been a few noteworthy implementations of gamification in learning activities. One of the purposes of those implementations was to enhance student engagement in learning. A good example is the Ibanez et al. (2014) study. They evaluated the impact of gamified learning activities (based on the study of C-programming language) on student engagement. They designed the gamified learning platform (named Q-Learning-G) by combining game elements (e.g., points, leaderboard, badges) with this platform, and then used it with students. According to their experiment, it is indicated that a gamified learning environment can engage students to learn.

Another study is by Leaning (2015), who examined the use of games and gamification to enhance student engagement on a theory-based course of an undergraduate media degree, in which the experimental group of students taking the gamified module enjoyed the course and put in more effort. However, the results of this study did not find evidence that gamified learning enhanced the students' attainment.

In addition, there have been studies focused on developing the educational website or software incorporated elements of gamification (e.g., Geelan et al., 2015; Kuo & Chuang, 2016; Nevin et al., 2014). Their findings were very consistent: the implementation of a gamification mechanism would increase the level of user engagement.

In summary, the results of these studies indicated the potential of applying gamification in learning activities, in order to engage students.

Methodology

Participants

The quasi-experimental nonequivalent-control group design was used with 577 undergraduate students from six Information Literacy Skills classes, in a university located in Thailand. The students in three of the classes were assigned to be the treatment group whereas the students in the others were the control group. Students in the treatment group (N = 304, Males = 28.3%; Females = 71.7%) attended a course designed for the gamified learning activity, while students in the control group (N = 273, Males = 20.9%; Females = 79.1%) attended a regular course. Both the treatment group and the control group had the same subject matter and materials. The only thing that differed was the treatment group's learning activities which were created from gamification concepts.

Measurement and data collection procedure

For the purpose of the investigation, a self-reported questionnaire was given to students in both the treatment group and the control group, at the end of the semester. The questionnaire was written in Thai and divided into three parts. The first part of the survey asked for general information on sex, academic year, faculty, and major. Part two of the survey assessed student engagement in learning, adapted from instruments developed by Arbaugh (2000), Athiyaman (1997), Cunningham (2007), Vernadakis, Giannousi, Tsitskari, Antoniou, and Kioumourizoglou (2012), and Wang and Holcombe (2010). The 20 items of this part are five-point Likert scale statements. All the scale points of the first twelve items were labelled, ranging from 1 ("Strongly disagree") to 5 ("Strongly agree") (sample items: "I enjoyed going to class"; "The class activities were engaging"). The scale points of the remaining items were labelled, ranging from 1 ("Almost never") to 5 ("Almost always") (sample items: "How often do you have trouble in class because it is hard for you to sit in your seat for a long time?"; "How often do you have trouble in attending a class?").

In order to avoid influences caused by students' individual differences, *the motivational goal orientation, computer self-efficacy, and perception of meaningfulness in the classroom learning environment* were considered covariate variables. The last part of the survey, therefore, was designed to measure and assess these variables. There were three sections; each section used the 5-point Likert scale, ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"). The first section of this part assessed students' motivational goal orientation, based on instruments developed and validated by Poondej et al. (2013). This 18-item section measures three dimensions of motivational goal orientation, namely the mastery goal (focused on mastering tasks, learning, and understanding) (e.g., "I feel satisfied when I learn new things in my class"), the performance-approach goal (desiring to demonstrate ability, and wanting to be superior to others) (e.g., "The most important thing is that other people should think of me as excellent"), and the performance-avoidance goal (avoiding failure or looking incompetent in comparison to others) (e.g., "I avoid asking questions because I don't want to look stupid").

The computer self-efficacy scale (Papastergiou, 2008) made up the second section. Samples of the scale's 10 items include, 'I am very confident in my ability to use computers', and 'I enjoy working with computers'. The last section, which was used to assess the students' perception of meaningfulness in the classroom learning environment, was adapted from Koul, Roy, and Lerdpornkulrat (2012). This section included five items (sample items: "In this class, new learning is connected with what you have learned previously", and "In this class, what you learn is important to you").

The internal consistency of the scales measuring student engagement in learning, mastery goals, performance-approach goals, performance-avoidance goals, computer self-efficacy, and perception of meaningfulness in the classroom learning environment was good (alpha = .872 for engagement in learning scale, alpha = .658 for mastery goal scale, alpha = .805 for performance-approach goal scale, alpha = .729 for performance-avoidance goal scale, alpha = .864 for computer's self-efficacy scale, and alpha = .774 for perception of meaningfulness in classroom learning environment scale).

Experimental design

In this study, we carried out an experiment in which an "information literacy skills" course was gamified, and student engagement was compared between a gamified group (treatment group) and non-gamified group (control group). The course is an undergraduate course that covers the principles, concepts, and practices of information literacy, including the critical thinking skills necessary to navigate, evaluate and use the many kinds of information resources available today.

Within the learning activities of the treatment group, we implemented a points system, levels, achievement badges, and leaderboards, which are all common elements of gamification mechanics. We used the CourseSites system (www.coursesites.com), which is a free online learning management system. This system allowed students to check their course activities,

points, levels, achievement rewards, and leaderboards. We set up each activity as a mission that students had to complete. Students earned experience points (often shortened to XP) after they completed the mission. Within each mission, students had options for reaching XP requirements for a particular level, and could select missions of interest, rather than completing missions in a fixed, linear progression. There were various types of mission assigned to this course (see Figure 1). The following examples will illustrate some of the different types of mission:

- G1: Profile update (25 XP): whenever students complete the update of their profile, they will earn 25 XP.
- G3: Taking a training course (25 XP): students will be assigned to take at least one training course program provided by the central library of the university.
- L1: Introduction to information literacy (165 XP): students will be asked to read an article and then take a quiz in the CourseSites system.
- C1: Attendance, participation, and section requirements (25 XP / time): students who attend the regular class or any special section will earn 25 XP.

The scoring processes of the missions that couldn't be used with the CourseSites feature were carried out manually by directly entering scores into the CourseSites system.

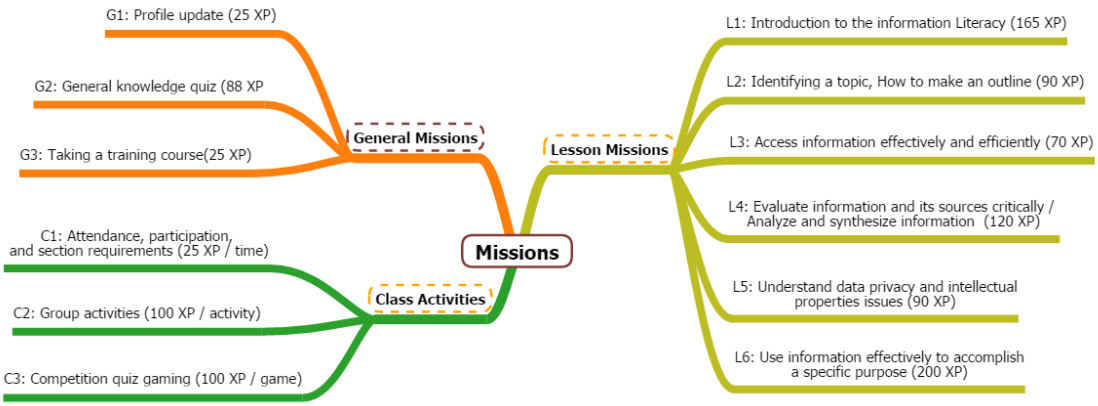

Figure 1. Screen capture showing all missions within the course.

In order to move up a level, students had to earn the required amount of XPs, which they could see on the online system. Furthermore, we developed the leaderboard webpage, which provided an entry point to the gamified experience and displayed the various levels in it.
In addition, we also included achievement rewards, which are badge icons displayed publicly on the online system. Students can see which achievement rewards they have earned and what is required to receive additional rewards (see Figure 2).

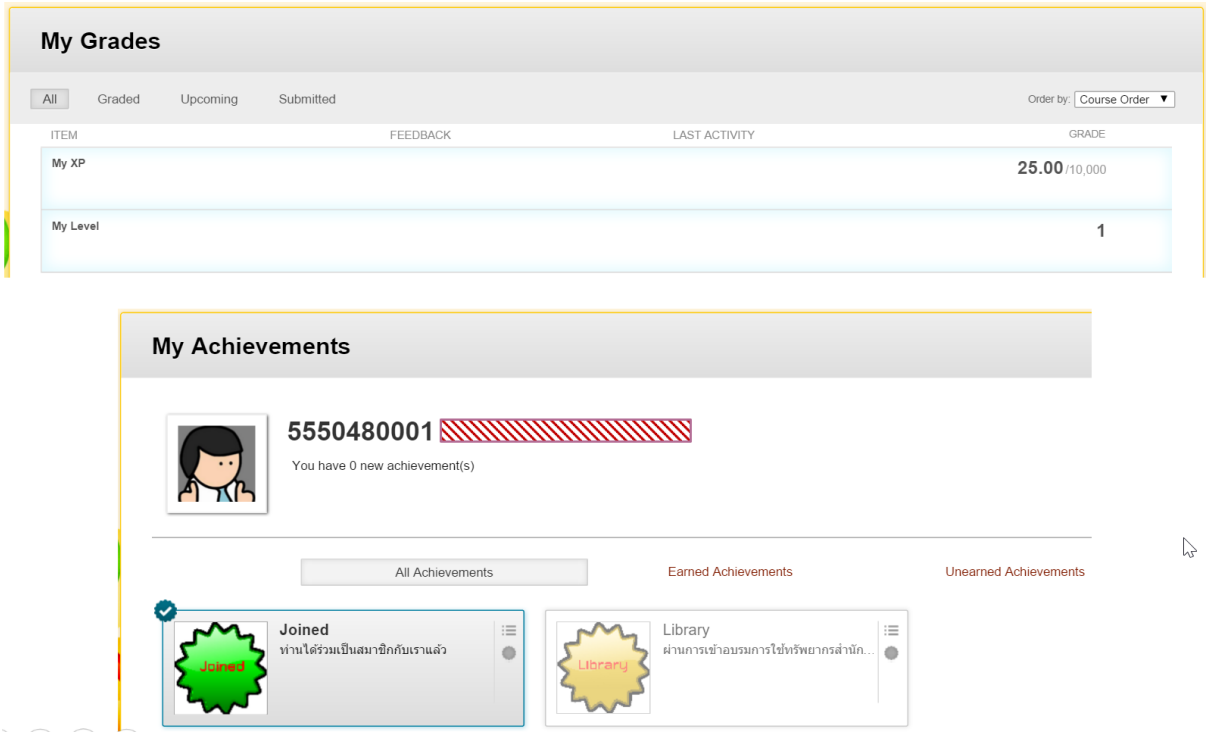

Figure 2. Screen capture showing students' XP, level, and achievement reward.

Data analysis

Due to the characteristic differences between participants in the control group and treatment group, we used the propensity score matching (PSM) approach to estimate the unbiased treatment effect in this study. PSM is a technique used to select control cases who are matched with treated cases, based on controlled background covariates. We considered *motivational goal orientation (mastery goal, performance-approach goal, and performance-avoidance goal), computer self-efficacy, and perception of meaningfulness in the classroom learning environment* to be potential covariate variables, then matched cases based on these baseline variables.

To perform the PSM procedure, we used the Matchlt in R package. We chose to use nearest neighbor matching, and since in our case there were more treatment cases than control cases, we used the replacement=TRUE option, so that a control case could be used more than once. Results using the PSM procedure indicated a good improvement in all controlled covariates (see Table 1).

After performing PSM, only the matched data (n = 273 for data in the control group and n = 273 for data in the treatment group) were used in analysis. A One-Way ANCOVA was conducted to determine a statistically-significant difference between students in the treatment group and students in the control group, based on their engagement in learning. The covariates of *motivational goal orientation (mastery goal, performance-approach goal, and performance-avoidance goal), computer self-efficacy,* and *perception of meaningfulness in classroom learning environment* were controlled in this analysis.

Table 1
Summary statistics of matching success

Controlled covariates	Mean Difference		Percent Balance Improvement
	Before matching	After matching	
Mastery goal	-.1289	-.0733	43.182
Performance-approach goal	.0098	.0044	54.9963
Performance-avoidance goal	.1222	.0641	47.5332
Computer self-efficacy	-.0958	-.0619	35.4013
Meaningfulness	-.1481	-.0821	44.6113

Results

To test the important assumptions in ANCOVA, the homogeneity test of regression slopes was performed, and the results revealed that each interaction between the independent variables and covariance was not significant. This confirms that ANCOVA could be applied. Table 2 presents descriptive statistics and ANCOVA results, in which there were statistically-significant differences between the treatment and control groups with regard to engagement in learning. A partial eta-squared measure, used for the effect size, was computed; the result was .152, indicating a large effect size. As the interpretation of the effect size is based on the recommendations by Cohen (1988), the specific values are .01, .06, and .14 for a small effect, medium effect, and large effect, respectively.

Results also showed that those variables (computer self-efficacy, meaningfulness, mastery goal, performance-approach goal, and performance-avoidance goal) were positively associated with engagement in learning. In addition, both the observed and adjusted means (shown in Table 2) indicated that students in the treatment group had a higher engagement in learning than students in the control group.

Table 2
Descriptive statistics and ANCOVA results for students' engagement in learning by the type of group, and controlling for motivational goal orientation (mastery goal, performance-approach goal, and performance-avoidance goal), computer's self-efficacy, and perception of meaningfulness in classroom learning environment.

Type of group	Students' engagement in learning			
	Observed Mean	Adjusted Mean	SD	n
Control	3.41	3.46	.40	273
Treatment	3.76	3.75	.41	273
Total	3.58	3.60	.44	546

Source	SS	df	MS	F	Partial Eta Squared
Computer self-efficacy	1.029	1	1.029	8.745**	.016
Meaningfulness	6.288	1	6.288	53.419***	.090
Mastery goal	9.497	1	9.497	80.687***	.130
Performance-approach goal	1.452	1	1.452	12.339***	.022
Performance-avoidance goal	.815	1	.815	6.927**	.013
Type of group	11.398	1	11.398	96.840***	.152
Error	63.442	539	.118		

Note. $R^2 = .401$, Adjusted $R^2 = .394$. Homogeneity of regression tested and not significant for each of the covariate by dependent variable interactions.
** $p < .01$; *** $p < .001$

Discussion

The aim of this study was to evaluate the learning engagement of gamified learning activities. These activities targeted the learning on an "information literacy skills" course that is a core course in a general education program. We designed gamified learning activities with a combination of online and offline learning activities. The points system, levels, achievement badges, and leaderboards, which are gamification elements, were used in these learning activities.

We found that there was a significant difference in effects on learning engagement between the two groups of students, after controlling the individual difference factors (*motivational goal orientation, computer self-efficacy,* and *perception of meaningfulness in the classroom learning environment)*. Students in the treatment group had a higher engagement in learning than students in the control group. These results implied that a gamified learning activity generates higher levels of engagement in learning.

Our findings align with existing literature on the positive effects of gamified learning activities on student engagement (Geelan et al., 2015; Ibanez et al., 2014; Kuo & Chuang, 2016; Leaning, 2015; Nevin et al., 2014). A possible explanation of why gamified learning activities can affect student engagement is the benefits of using game mechanics.

The points and levels systems, in which points are generally awarded for the completion of tasks and then accumulated, were used in the gamified learning activities of the treatment group. As suggested in the game and gamification design literature, points and levels are indicators of self-performance (Cheong et al., 2014), so they are important tools for students tracking their achievement. Not only were the points and levels systems used in the gamified learning activities, but badges were also used. In this study, we used digital achievement badges, one of the game mechanics, as symbols or indicators of the accomplishment of various achievements in the learning task. Also, we used them to serve as student goals, so that students would need to be committed to pursuing them, and would think of badge achievement as obtaining a reward. Gamification studies have found that achievement badges can be used to affect students' behavior and as a promising method to increase user engagement (e.g. Hakulinen, Auvinen, & Korhonen, 2015; Hamari, 2015).

Moreover, in the gamification context, points (Attali & Arieli-Attali, 2015) and badges (Abramovich, Schunn, & Higashi, 2013) are considered as types of formative feedback to students in two ways. The first way is that they provide students with their competency level. The second way is that they allow students to reflect on how much effort, motivation, or engagement they should invest into their learning. From a theoretical perspective, feedback will have a positive effect on learning when it is related to the process of learning and it can be done through both cognitive processes and affective processes (Hattie & Timperley, 2007; Sadler, 1989, as cited in Attali & Arieli-Attali, 2015). Thus, the effect of providing instant feedback is likely to be a key mediator between the use of game mechanics (points and levels systems, and digital achievement badges) and increased student engagement.

Another theoretical perspective which can explain the effect of the points system, the levels system, and digital badges, in this context, is that of extrinsic motivation. According to self-determination theory (Ryan & Deci, 2000), extrinsic motivation refers to doing something because it leads to the attainment of a desired outcome. Collecting points and collecting badges also function as extrinsic rewards for the students. They are motivated to perform a behavior or engage in learning activities to earn rewards. Thus, extrinsic motivation is another possible mediator between using points and levels systems, and digital achievement badges. An additional game mechanic used in these gamified learning activities was a leaderboard system. The purpose of the leaderboard in this study was to visually show students where they rank among the top 20 students in the class, during the experimental task. In the context of gamification, leaderboards usually motivate users by making one's personal performance visible, and allowing users to see how well they are doing compared to their friends. Many theories can explain the effect of leaderboards on user's behavior, such as Maslow's hierarchy of needs, Alderfer's ERG theory, McClelland's need theory, and acquired need theory. These theories point out that in a social environment, most humans

have the need to socialize, and seek social recognition and status (Vassileva, 2012). They also desire reputation, respect of others, and value a feeling of fame (Oh, 2012).

On the other side, according to the social comparison theory (Festinger, 1954, as cited in Hamari, 2015), it is stated that individuals are more likely to compare themselves with others and engage in behaviors that they perceive others are also engaged in. Then, they need to engage themselves in activities to satisfy these desires. It seems that the theories mentioned above can be served by using leaderboards. When students checked their reputation status in the visualization, and compared their ranking with others, it might have been the trigger to persuade students to take part in the learning activities.

To sum up, the game mechanics used in these gamified learning activities have proven to be useful for increasing student engagement in learning. They are driven by many theories behind them. These theories can be the mediators between using game mechanics and student engagement in learning.

Conclusion

Gamification of education is an educational approach to which game mechanics are applied. The main objective is to motivate students to participate and engage in learning. This study contributes to education literature by demonstrating the influence of applying gamification techniques to increase student engagement in learning. Our study indicates that gamified learning activities increase student engagement in learning. The results of this study suggest that gamified learning activities should be considered a serious strategy to promote student engagement. Furthermore, elements of gamification – points, badges, and leaderboards (called PBL) – should be integrated into the existing framework of engaged learning, because they are the key factors that influence students' behavior.

However, the study contains some limitations. Firstly, since self-reported methodologies were used in this study to collect information from students, the results may not reflect the full truth of their manner because of the possibility of response distortions. Secondly, due to the limitation of budgets for learning management software, we used the free online learning management system which did not provide all of the gamification functions, such as leaderboards. Then, we had to make a website and set it up as a leaderboard, which was updated once a week. Students could not see real-time updates on the leaderboard after finishing the tasks. This may have caused a lack of motivation in competition and diminished the benefit of using leaderboards.

This presents a valuable opportunity for future studies to be conducted. In future work, other data collection methods, such as observations and interviews, should be considered in the study design. Also, future work should examine the other dependent variables that might result from implementation of gamified learning activities, especially the perception of gamification elements and learning outcomes.

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