THE ROLE OF GAMIFICATION TECHNIQUES IN PROMOTING STUDENT LEARNING: A REVIEW AND SYNTHESIS

Islam Alomari	Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia	eslamom85@yahoo.com
Hosam Al-Samarraie*	School of Media and Performing Arts, Coventry University, Coventry, UK	h.alsamarraie@coventry.ac.uk
Reem Yousef	General Education Department, Al Falah University, Dubai, UAE	reem.yousef@afu.ac.ae

* Corresponding author

ABSTRACT

Aim/Purpose	This study reviewed previous research on the role of gamification techniques in promoting students' learning.
Background	The role of gamification in promoting students' learning has been investigated empirically by many scholars. To date, mixed results about the effectiveness of gamification have been reported, and researchers frequently argue that the inappropriateness of certain techniques may have contributed to these mixed findings.
Methodology	The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol was used to assess the criteria required for this review. A total of 40 studies were identified and included in the systematic review. The selected studies were used to assess the association between certain gamification techniques and students' learning in this study.
Findings	The results showed that gamification techniques differently affect students' learning. In addition, it is important for students to be instructed about the application of gamification approach before they engage in a gamified learning task. The key challenges relating to the use of gamification techniques were also discussed.

Recommendations for Practitioners	This review can help educational decision makers and practitioners to stimulate certain learning outcomes of the students with the help of specific gamification techniques.
Keywords	gamification, gamified learning activities, higher education, lifelong learning

INTRODUCTION

Gamification, as a concept, is defined as the techniques used in non-game settings (Deterding, Dixon, Khaled, & Nacke, 2011). Gamification techniques are commonly used in higher education to increase learners' motivation and engagement in a learning task. Students' engagement in a gamified learning activity can result in a better learning outcome (Barata, Gama, Jorge, & Gonçalves, 2013; Eleftheria, Charikleia, Iason, Athanasios, & Dimitrios, 2013; Kuo & Chuang, 2016). Many previous studies on gamification have argued that by motivating students through a reward-based learning method, their learning skills will be enhanced and eventually increase their learning outcomes (Buckley & Doyle, 2016; Domínguez et al., 2013; Kim, Song, Lockee, & Burton, 2018). Despite these studies, there are some mixed findings reported in the literature about the potential of gamification in facilitating students' learning in different settings. For example, Landers and Armstrong (2017) reported that gamification may not effect changes in instructional outcomes when learner attitudes towards game-based learning are low. Thornton and Francia (2014), on the other hand, stated that the application of gamification may not be applicable to all curriculum, which may result in unfavorable consequences.

Recently, various gamification techniques have been used to gamify learning experiences such as points, prizes, badges, leaderboards, scoreboards, challenges, levels, and feedback (Barata et al., 2013; Kim, Rothrock, & Freivalds, 2016; Yildirim, 2017). Applying gamification techniques in a curriculum can help provide a more inclusive activity through its effect on students' sense of competition, interaction, and motivation (Aşıksoy, 2017; Davis, Sridharan, Koepke, Singh, & Boiko, 2018). Still, many previous studies have shown that gamification techniques may not necessarily offer the best option and outcome of learning to the students (Ding, Er, & Orey, 2018; Van Roy & Zaman, 2018). Mekler, Brühlmann, Tuch, and Opwis (2017) found that gamification did not significantly improve students' grades as most of them were unfamiliar with the protocol of gamification. Students' unfamiliarity with the gamification approach has been reported by many previous studies as the main reason for not completing the task (Butler & Bodnar, 2017; Kim, 2013). In addition, some students in the gamified learning task were found to require more time to understand the gamification process (Ding, Kim, & Orey, 2017). Thus, this study argues that applying certain gamification techniques may impose favorable and unfavorable consequences on students' learning. The literature also showed that providing students with the appropriate learning activities/instructions can help facilitate communication and interaction between them in any learning setting (Lao & Gonzales, 2005; Shirrell, Hopkins, & Spillane, 2018). Recently, several gamification techniques have been used to stimulate students' various learning outcomes (Butler & Bodnar, 2017; Filatro & Cavalcanti, 2016; Kim, Rothrock, & Freivalds, 2016; Ortiz-Rojas, Chiluiza, & Valcke, 2017; Van Roy & Zaman, 2018). However, it is still debatable how certain gamification techniques can stimulate learners' learning. This study aims to characterize the gamification techniques and the purpose of using them in creating a gamified learning activity. Precisely, the authors conducted a systematic review of the literature to determine the role of gamification techniques in promoting students' learning. Outcomes from this review can help educational decision makers and practitioners understand how to stimulate certain learning outcomes of the students with the help of specific gamification techniques.

METHOD

The researchers reviewed empirical studied on the effects of gamification elements or techniques on students' learning in a university context. The selected articles, which have been published in peer reviewed journals or conferences, were gathered to answer the following questions: 'How can gamification elements/techniques be used to promote students' learning?' and 'What are the challenges in implementing them in a university context?'

RESEARCH STRATEGY

This work included empirical studies that were published during 2016 to 2018, particularly because most reviews about gamification were found till 2016 (Caponetto, Earp, & Ott, 2014; Dicheva, Dichev, Agre, & Angelova, 2015; Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner, 2014; Subhash & Cudney, 2018; Surendeleg, Murwa, Yun, & Kim, 2014). The literature of the present review was obtained from various databases, including Google scholar, Springer, ERIC (education resources information system), IEEE Xplore and Science Direct. Certain keywords were used to search for the articles ("gamification" OR "gamify" OR "gamified") AND ("higher education" OR "undergraduate students" OR "postgraduate students" OR "university students" OR "university level"). A total of 8468 articles were identified through database searching. 1192 out of these articles were removed due to duplicates. A total of 7276 articles were screened for relevance. Of these, 7219 articles were removed by title. Then, the full text of each remaining article (total 57 articles) was read in which 17 articles were removed as they did not present sufficient statistics. The articles were arranged using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, which has been recommended by many previous studies (Al-Samarraie & Saeed, 2018; Neeley, Ulman, Sydelko, & Borges, 2016; O'Flaherty & Phillips, 2015; Sardi, Idri, & Fernández-Alemán, 2017) (see Figure 1).

The identified articles (n:40) were written in English, presented empirical findings within a higher education setting, and published in peer-reviewed journals or proceedings. In addition, articles used in this review included measures of the effects of gamification elements on students' learning (e.g., performance, achievement, and motivation).
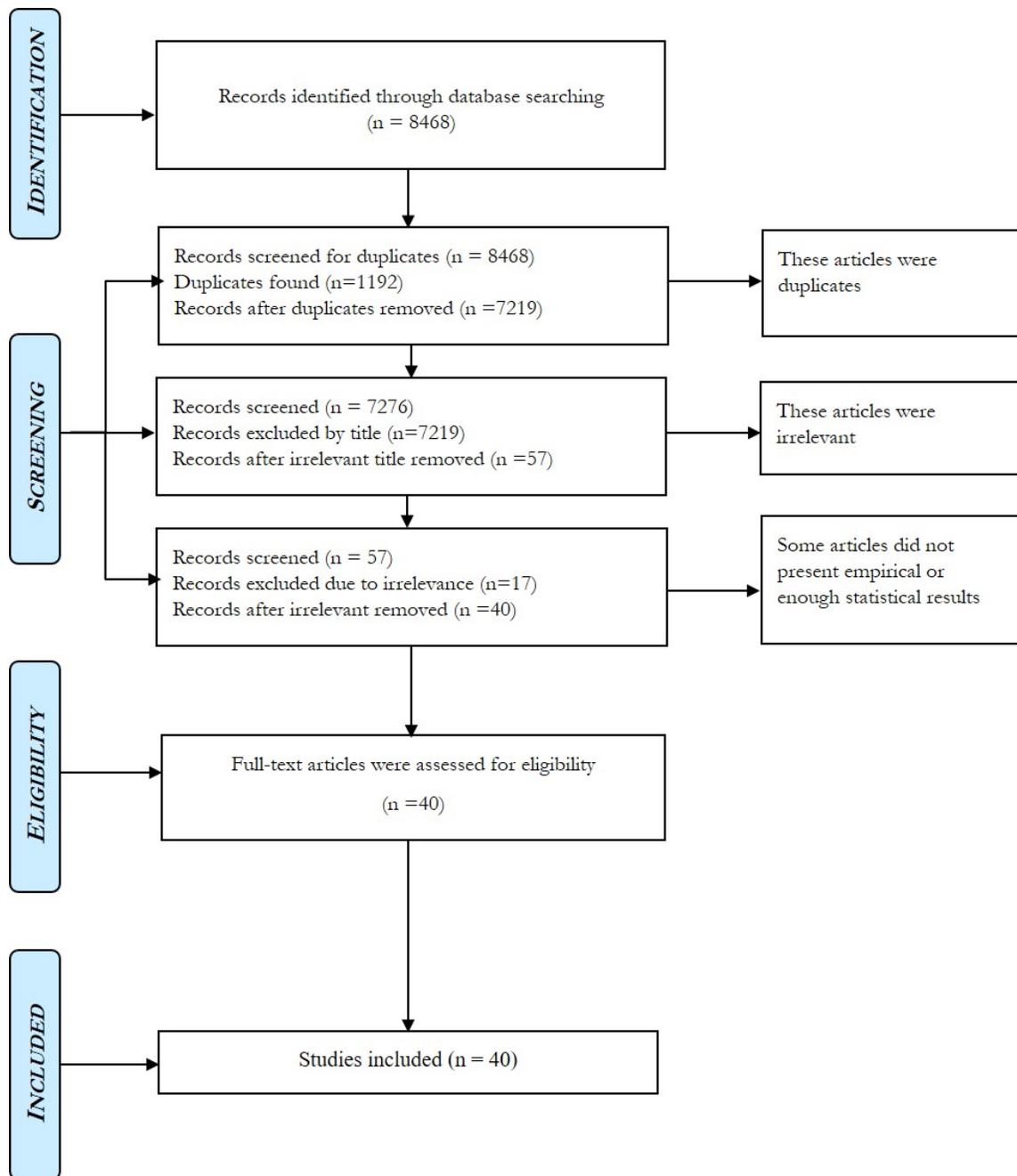
Figure 1: The selection process of articles

QUALITY ASSESSMENT

The identified articles were evaluated by the researchers to satisfy the criteria of relevance and quality. Evaluating the relevance and quality of the selected articles in the present review was established by following the recommendations of Sardi et al. (2017). The following criteria were used to evaluate the relevance and quality of the identified articles:

1. The sample size is enough to generalize the study's findings.
2. The research procedures are discussed adequately in the text.

3. The statistical data provided sufficient constraints to allow the researchers to assess the effects of gamification on students' learning.
4. The study is published in a peer-reviewed journal or in a conference proceeding.

The weight of each selected paper was assessed based on the available evidence calculated by summing scores on each of the four criteria above by the two researchers (8 scores, 2 for each criteria). The researchers considered an article to be low quality (1) when it received 2 or less scores; medium quality (2) when it received 3-5 scores; and high quality (3) when it received more than 5 scores. The inter-rater reliability (r) result for all articles was .85, showing a good agreement between the researchers. The quality check result resulted in 16 articles that were categorized as medium quality and the rest (24 articles) were categorized as high quality.

RESULTS

Figure 2 shows the type of gamification techniques used in the selected articles. From the figure, it can be said that the most commonly used techniques in the previous works were: points (75%); badges (68 %), leaderboards (63%), levels (38%). Other gamification techniques (e.g., rewards, progress bar, challenges, feedback, and avatar) were found to be less utilized. Appendix TableA1 shows previous studies on the utilization of gamification techniques in higher education. The following subsections explain these techniques.
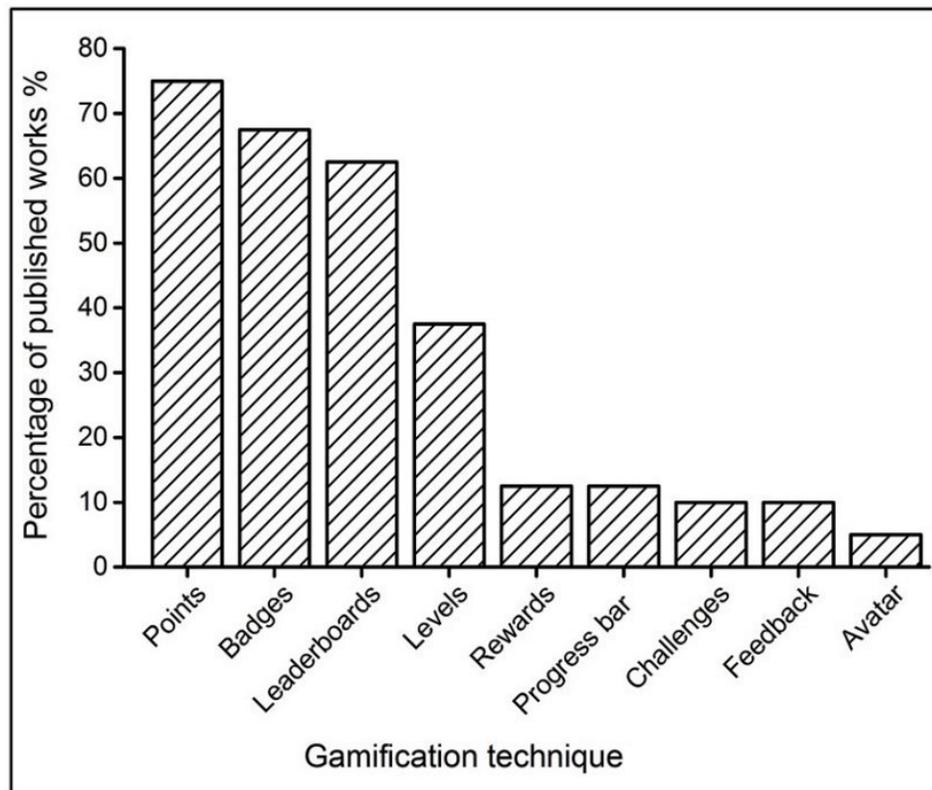
Figure 2: Gamification techniques used in previous studies

POINTS

Points are defined as numerical values that are used to evaluate individuals' performance metrics in game and non-game contexts (Brewer et al., 2013). Many previous studies have addressed the potential of point-based system in increasing students' motivation, particularly when performing computational tasks (Diniz, Silva, Gerosa, & Steinmacher, 2017; Wang & Lieberoth, 2016). The potential of

using this technique in facilitating students' learning has been addressed in the works of Aşıksoy (2017); Kuo and Chuang (2016) who showed how the point-based system can help teachers establish a positive competition learning-environment in order to motivate students in their learning activities. This includes stimulating individual's desire for reward which serve as credits in an academic environment. In addition, point-based system can stimulate learners' engagement due to its role in creating a fun and enjoyable experience, which encourage the students to interact more with the learning environment in various domains (Davis et al., 2018). Hew, Huang, Chu, and Chiu (2016) stated that the point-based system can be a useful game technique to make individuals feel challenged, as well as offering students feedback on their progress and rank users based on their level of participation (Huang & Ho, 2018). Based on these observations, this study anticipates that the use of points to gamify the learning activity can help in creating a competition-fun environment in which a group of students try to think about views/ideas to argue with others. This process is believed to motivate students to participate frequently for the sake of receiving more points. Outcomes from such practices can help in reducing the instructor's role, which is very important for promoting student-centered learning. This further suggests that utilizing the point-based system can motivate students to engage in a sharing network that is more likely to be accepted by the other group members. Other previous studies have reported a notable effect of using points in improving the performance of students (De-Marcos, Garcia-Lopez, & Garcia-Cabot, 2016; Mekler et al., 2017) due to its role in increasing the number of answered questions by the individual students (Denny, McDonald, Empson, Kelly, & Petersen, 2018).

BADGES

Badges are defined as a visual representation of achievements that can be earned and collected in the gamified activity (Seaborn & Fels, 2015). Many studies used badges as a gamification technique to reinforce learners' motivation, mainly by increasing the individual's sense of competence and self-determination (Suh, Wagner, & Liu, 2018; Van Roy & Zaman, 2018). The application of badges in online learning tasks has been reported to help maintain students' engagement in their learning (Filatro & Cavalcanti, 2016). According to Huang, Hew, and Lo (2018), badges can enable students to become active learners by giving them confidence to take part in the class discussion and promote them to produce higher quality results. Enabling students to earn badges through badge-based learning pathways will increase the social interaction among them (Ding et al., 2018). In addition, students' motivation in the learning task can be stimulated with badges (Balci, Secaur, & Morris, 2018; Butler & Bodnar, 2017) by encouraging them to spend more time and devote more effort to earn more recognition (Ding et al., 2018). Previous studies (Denny et al., 2018; Rincon-Flores, Gallardo, & de la Fuente, 2018) have also emphasized the role of badges in improving the performance of learners. For example, when students are encouraged to discuss cases and exchange ideas with others, they are likely to establish positive attitudes toward the task, thus enhancing their performance (Balci et al., 2018). Meanwhile, when a learner makes an achievement, he/ she will gain a badge that could stimulate other learners to devote more effort to the task, resulting in enhancing the overall learning outcomes.

LEADERBOARDS

Leaderboards refers to the use of an electronic board to display the ranking of leaders (users) in a competitive learning situation (Seaborn & Fels, 2015). The use of leaderboards in online learning tasks have been found to promote students' learning behaviors by creating a sense of competition between learners. This is believed to help sustain students' motivation in the learning activity (Schreuders & Butterfield, 2016). In addition, leaderboards have played an important role in increasing students' performance by allowing them to see the performance of their classmates and which, as a result, stimulate individuals to become more involved in the learning process (Suh et al., 2018). Many previous studies have also reported that using leaderboard as a gamification technique in the learning process would increase students' motivation (Kuo & Chuang, 2016; Roosta, Taghiyareh, &

Mosharraf, 2016) by creating a social comparison among the learners which motivate them to increase their contribution rate (Hew et al., 2016). Students' engagement in the learning task can be also increased with leaderboards (Ding et al., 2018; Kim et al., 2016) based on the sense of reputation a learner may attain when he/ she get a higher rank as compared with others (Aldemir, Celik, & Kaplan, 2018). This can enhance students' interactions with the subject under discussion and, eventually, increase their scores.

LEVELS

The levels-based system is used commonly to rank individual's progress in stages based on the difficulties, challenges, or questions he/she need to complete in order to get to the next stage. The lower the level an individual needs to achieve, the less difficult the task will be. However, the higher the level a student needs to complete, the more effort and time he/she needs to spend (Nah et al., 2014). Several studies have reported that the levels-based system can improve students' motivation while learning complex topics (Butler & Bodnar, 2017; Diniz et al., 2017; Kim et al., 2016; Mekler et al., 2017). This can be due to the potential of this technique in creating a sense of flow when the student loses track of time pursuing an activity that is both fun and challenging. The consequence of such experience is believed to stimulate individual students' motivation to complete the next level. Some researchers (e.g., Filatro & Cavalcanti, 2016; Khalil, Ebner, & Admiraal, 2017; Schreuders & Butterfield, 2016) have reported the influential role of levels-based system in promoting students' engagement, mainly through students' reports and interactions with the gamified platform. The researchers in this study believe that using this technique in a university context would help in creating a social pressure on learners to have the will to perform well on the task at hand. This includes increasing their efforts to achieve interpersonal and small-group skills. This method has also been used to facilitate students' performance (Kim et al., 2016; Mekler et al., 2017; Rincon-Flores et al., 2018) through the process of goal setting. For example, when students are engaged in the gamified learning activity, they are likely to undergo motivational and behavioral changes subject to the limits of constraints such as one's ability. This may increase students' potential to get higher levels of confidence by critically analyzing tasks and actively integrating knowledge with incoming information. These experiences can affect students' performance, thus enhancing the overall learning process.

OTHER TECHNIQUES

Other gamification techniques, such as rewards, progress bar, challenges, feedback, and avatar, have been used either alone or along with other gamification techniques mentioned above. Ding et al. (2018) reported that using rewards-based system can result in a positive effect on learners' motivation and engagement. In addition, other previous studies (e.g., Ding et al., 2018; Roosta et al., 2016) have indicated that using progress bar for gamifying a learning activity can improve the motivation and engagement of learners by allowing students to track their progress and identify the contribution of each member throughout the learning session. Feedback, as a gamification technique, has also been used by few scholars as an attempt to improve students' motivation, engagement, and performance in different leaning settings (Kim et al., 2016; Roosta et al., 2016). This includes reminding students to contribute to the development of their own learning, as well as communicating the progress of their learning with other members. In addition, other scholars (e.g., Rincon-Flores et al., 2018; Van Roy & Zaman, 2018) have reported that gamifying the learning activity by increasing the level of challenge can stimulate students' motivation and performance in a learning task. Avatar-based system has been used rarely in previous studies (Rincon-Flores et al., 2018) in which its use was limited to the development of students' learning performance. Thus, the utilization of certain gamification techniques can help promote different learning behaviors and outcomes. Appendix Table B1: shows how certain gamification techniques can promote students' learning.

CHALLENGES

Despite the positive effects demonstrated by the use of gamification techniques in higher education on students' behavioral and learning outcomes (e.g., motivation, engagement, and performance) (Bovermann & Bastiaens, 2018; Huang et al., 2018; Ortiz-Rojas et al., 2017), there are a number of challenges that need to be addressed. For examples, previous studies on gamification in a university context (Ding et al., 2018; Van Roy & Zaman, 2018) have reported that some students may not inter-act with the gamified learning task due to their unfamiliarity with gamification and its strategies. Some students may not be able to engage in the learning activity due to the fears of failure, which, as a result, influences their interest in taking part in the learning activity. In addition, the competence of a person may change when the context changes (Fischer, Bullock, Rotenberg, & Raya, 1993). The changes in competency levels of students may lead to some undesirable consequences, including students' frustration and loss of self-confidence (Butler & Bodnar, 2017). According to Ding et al. (2017), some students in the gamified learning activity may require more time to acquire the necessary understanding for them to progress effectively through the learning process. As such, instructors still need provide the support and encouragement for students to have a better understanding of what will be expected of them (Sailer, Hense, Mayr, & Mandl, 2017). Özdener (2018) reported another challenge of using gamification in a Wiki environment. She found that teachers of the course did not possess an adequate level of consciousness of the fact that student capabilities are an important factor in learning the task. Students in the gamified activity must be able to cooperate effectively with other students. In addition, helping the instructors to improve their technological skills is a vital aspect that can be crucial to the overall success of integrating gamification into learning activities. Aldemir et al. (2018) stated that it is difficult to use single gamification element to evaluate its effectiveness in promoting students' perceptions. Çakıroğlu, Başıbüyük, Güler, Atabay, and Memiş (2017) reported that students who did not achieve a desirable performance showed negative views about the effectiveness of the gamification process. This concern has been also supported by Piteira, Costa, and Aparicio (2017) who reported that students felt uncomfortable when their names did not appear on the leaderboards. Furthermore, gamification may not motivate all students the same way (Hew et al., 2016), which can be due to individual differences between students within one classroom. Finally, the use of gamification in a large assessment program may not results in a set of evenly distributed feedback. This is because students in the gamified task needs more time to manage their thoughts and ideas (Schreuders & Butterfield, 2016). Therefore, a successful gamified learning task should be designed in a way that ensure students acquire the experiences and practice they need to successfully share and progress in the learning task.

CONCLUSION

Improving the motivation and engagement of learners in learning activities is important for the development of skills and competences. The review of the literature revealed that several gamification techniques, such as points, badges, leaderboards, levels, rewards, progress bar, challenges, feedback, and avatar, can be used to gamify learning experiences in different university courses. The results showed the potential of using gamification techniques in promoting learners' motivation, engagement, and performance, mainly by establishing a comparative learning-environment that influence how a student learn, not necessarily the context in itself. This includes creating a fun statement among students that encourage them to be more engaged with the learning task, thus increasing their interest and motivation. Understanding how gamification techniques affect the behavior of learners can help researchers and instructors to select the suitable techniques for their students. This understanding is vital for context's designers where they need to choose the suitable gamification interventions that can stimulate students during the discussion session. In addition, it is important for students to be instructed about the application of gamification approach before they engage in the discussion. Previous studies seem to provide poor guidance to future researchers about the suitability of

gamification techniques for achieving a certain learning objective. Providing enough knowledge about these issues is vital to understand the role of gamification in education.

COMPLIANCE WITH ETHICAL STANDARDS

1. Disclosure of potential conflicts of interest: The authors declares that they have no relevant or material financial interests that relate to the research described in this paper
2. Research involving human participants: This research involves no human subjects.
3. Informed consent: This research is a review study in which informed consent is not necessary.

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APPENDICES

APPENDIX A

Table A1: Previous Studies on Gamification in Higher Education

Study	Purpose	Sample / Domain	Elements / Techniques	Method	Variables	Outcomes
Van Roy and Zaman (2018)	Examined the effects of gamification on students' motivation.	40 students / English	Challenges, badges, and group competition	Survey	Motivation	Gamification had a positive effect on students' motivation.
Suh, Wagner, and Liu (2018)	Investigated the role of gamification in promoting students' engagement in a learning task.	164 students/ Multi-discipline	Points, levels, badges, and leaderboards	Survey	Engagement	Gamification enhanced user engagement through the mediation of psychological needs satisfaction between game dynamics and enjoyment.
Thongmak (2018)	Studied how gamification can enhance students' problem-solving skills, engagement, attention, enjoyment, understanding, and creativity.	13 students / Business	Cards, points, comparisons, feedback, and social engagement	Interview	Problem solving, engagement, attention, enjoyment, understanding, and creativity	Gamification provided students with more time to solve problems, understand learning problems, increased their confidence, decreased recitation, and reduced their stress.
Delello, Hawley, McWhorter, Gipson, and Deal (2018)	Explored the effects of gamification on students' motivations and perceptions.	90 students / Multi-discipline	Badges	Survey	Motivations and perceptions	Using badges motivated students in their learning of the course content.
Balci, Secaur, and Morris (2018)	Investigated the impact of gamification on students' motivation and academic performance.	102 students / Physics	Badges and leaderboards	Survey	Motivation and performance	A positive influence of gamification on students' motivation was found, but not on their academic performance.
El Tantawi, Sadaf, and AlHumaid (2018)	Examined how gamification can support students' academic writing.	92 students / Dental	Storyline, points, badges, and leaderboards	Survey	Academic writing	Gamification improved students' academic writing skills.

Study	Purpose	Sample / Domain	Elements / Techniques	Method	Variables	Outcomes
Davis, Sridharan, Koepke, Singh, and Boiko (2018)	Studied students' experiences when learning in a gamified course.	139 students/ Informatics	Points, leaderboards, levels, and badges	Survey	Learning, achievement, and engagement	Gamification positively influenced students' learning, achievement, and engagement with the course materials.
Özdener (2018)	Explored the effects of gamification elements on students' participation rates and academic success.	63 students / Multi- discipline	Badges, leaderboards, rewards, and points	Mixed	Participation and academic success	The gamification strategy has a positive impact on students' participation and academic success in Wiki activities.
Aldemir, Celik, and Kaplan (2018)	Explored students' perceptions of a series of game elements in a gamified course.	118 students / Multi-discipline	Challenge, narrative, leaderboards, rewards, badges, win-state, points, and constraints	Interview	Perceptions	The gamified learning experience offered a dynamic nature with the interplays among different psychological, social, pedagogical, and game elements.
Bovermann and Bastiaens (2018)	Studied how gamification can enhance students' motivation.	97 students / Multi- discipline	Points and leaderboards	Survey	Intrinsic motivation	Gamification enhanced students' intrinsic motivation.
Huang, Hew, and Lo (2018)	Examined how gamification can be used to enhance student engagement in a learning task.	96 students / Management	Badges	Survey	Engagement	Gamification enhanced students' engagement during class activities.
Rincon-Flores, Gallardo, and de la Fuente (2018)	Investigated the potential of gamification as a technique to develop mathematical modelling competencies among students.	50 students / Calculus	Challenges, progressive levels, avatar, and badges	Mixed	Performance and meta-evaluative processes	Gamification introduced a high level of innovation and supplied the type of motivation and emotion essential for encouraging students' active participation in a learning task.
Ding, Er, and Orey (2018)	Examined the influence of the gamification approach on students' engagement.	14 students / Multi-discipline	Points, leaderboards, badges, progress bar, reactions, and awards	Mixed	Emotional engagement, cognitive engagement, motivation, and self-regulation	Increased students' engagement in online discussion.

Study	Purpose	Sample / Domain	Elements / Techniques	Method	Variables	Outcomes
Denny, McDonald, Empson, Kelly, and Petersen (2018)	Studied the role of gamification in facilitating students' engagement and exam performance.	701 students / Physiology	Points and badges	Survey	Engagement and performance	Gamification increased the learning outcomes of students.
Çakıroğlu, Başıbüyük, Güler, Atabay, and Memiş (2017)	Studied the effects of gamification on students' engagement and academic performance.	37 students / ICT	Leaderboards, reputation, real gifts, points and quests	Survey	Engagement and performance	Gamification had positive effects on students' engagement and academic performance.
Barna and Fodor (2017)	Evaluated the effectiveness of gamification in an IT course.	2500 students / Education	Points, badges, and levels	Survey	Participation and satisfaction	Gamification improved the course quality.
Sailer, Hense, Mayr, and Mandl (2017)	Investigated the effects of gamification on students' competence, autonomy (freedom to make decisions), and social relatedness.	419 students / Multi-discipline	Points, badges, leaderboards, and avatars	Survey	Competence, autonomy, and relatedness	Badges, leader boards, and performance graphs positively affected competence and satisfaction, as well as perceived task meaningfulness. Avatars, meaningful stories, and teammates affected experiences of social relatedness.
Butler and Bodnar (2017)	Determined the impact of a gamified homework on students' motivation.	41 students / Engineering	Points, badges, and levels	Survey	Motivation	Gamification had neutral impact on students' academic motivation.
Khalil, Ebner, and Admiraal (2017)	Studied how gamification elements in Massive Open Online Courses (MOOCs) can increase student engagement.	1763 students/ Multi-discipline	Levels	Survey	Engagement	Gamification enhanced students' outcome by promoting students' participation in learning activity, quiz trials, and engagement in discussion forums.

Study	Purpose	Sample / Domain	Elements/ Techniques	Method	Variables	Outcomes
Yıldırım (2017)	Investigated the effects of gamification on students' achievement and attitudes toward the gamified lesson.	97 students / Education	Points, badges, levels, and leaderboards	Survey	Achievement and attitudes	Gamification had a positive impact on students' achievement and attitudes.
Elabnody, Fouad, Maghraby, and Hegazy (2017)	Examined the potential of certain elements of gamification in stimulating students' experience and engagement.	115 students / Multi-discipline	Points, badges, and leaderboards	Survey	User experience and engagement	The gamified group had performed more activities than the non-gamified group. Gamification increased student engagement.
Ding, Kim, and Orey (2017)	Used gamification as an approach in online discussions to increase student engagement.	22 students / Multi-discipline	Points, levels, badges, progress bar, leaderboards, and thumbs –ups	Mixed	Engagement	Gamification increased students' engagement and motivation in the online discussion.
Aşıksoy (2017)	Studied the potential of using gamification to enhance students' motivations and learning achievement.	61 students / Physics	Points, leaderboards, and badges	Mixed	Motivations, learning achievements, and perceptions	Gamification increased students' motivation and learning achievement.
Diniz, Silva, Gerosa, and Steinmacher (2017)	Analyzed the use of gamification to orient, motivate, and engage undergraduate students.	17 students / CS	Points, levels, ranking, and quests	Survey	Motivation, engagement, and contribution	Gamification increased students' motivation, engagement, and contribution.
Tan and Saucerman (2017)	Assessed the impact of gamification in the context of in-class problem sessions.	104 students / Biomedical	Points and leaderboards	Survey	Motivation, enjoyment, and encouragement	Gamification promoted students' motivation, enjoyment, and collaboration.
Ortiz-Rojas, Chiluiza, and Valcke (2017)	Analyzed the impact of gamification on students' learning performance, intrinsic motivation, self-efficacy and engagement.	100 students / Engineering	Badges	Survey	Performance, intrinsic motivation, self-efficacy, and engagement	Gamification enhanced students' engagement. However, no significant impact on learning performance, intrinsic motivation, self-efficacy was found.

Study	Purpose	Sample / Domain	Elements / Techniques	Method	Variables	Outcomes
Mekler, Brühlmann, Tuch, and Opwis (2017)	Investigated the effects of gamification on intrinsic motivation, competence and performance of students.	273 students / Multi-discipline	Points, levels, and leaderboards	Survey	Intrinsic motivation, competence, and performance	The gamification elements promoted performance quantity, but not intrinsic motivation and competence.
Piteira, Costa, and Aparicio (2017)	Studied how the implementation of a gamified lesson can contribute to students' perception and attitude.	108 students / CS	Points, leaderboards, badges, levels and progress bar	Survey	Perception and attitude	The gamification elements positively influenced students' perception and attitude.
Roosta, Taghiyareh, and Mosharraf (2016)	Characterized the effects of gamification elements on learners' motivation.	273 students / Engineering	Badges, feedback, leaderboards, points, and progress bar	Survey	Motivation	The gamified session improved learners' participation.
Hew, Huang, Chu, and Chiu (2016)	Investigated the effects of gamification on student cognitive and behavioral engagements.	43 students / Educational studies	Points, badges, and leaderboards	Survey	Engagement	Gamification motivated students to engage in more difficult tasks.
Wang and Lieberoth (2016)	Explored how gamification can develop the general knowledge of learners in a non-formal education platform.	593 students / Multi-discipline	Points and leaderboards	Survey	Concentration engagement, enjoyment, learning, and motivation	Incorporate gamification elements into a web application enhanced the general knowledge of users in a non-formal education platform.
De-Marcos, Garcia-Lopez and Garcia-Cabot (2016)	Studied the role of gamification elements in enhancing the learning performance of undergraduate students.	379 students / Multi-discipline	Trophies, badges, and leaderboards	Survey	Performance	Gamification increased the learners' performance.
Kuo and Chuang (2016)	Applied gamification to an online context for academic promotion and dissemination.	73 students / Multi-discipline	Points, leaderboards, and badges	Mixed	Engagement and motivation	Gamification elements had a positive impact on students' motivation and engagement.

Study	Purpose	Sample / Domain	Elements/ Techniques	Method	Variables	Outcomes
Kim, Rothrock, and Freivalds (2016)	Explored the effects of gamification on students' engagement in lab-based activities.	100 students / Engineering	Points, levels, badges leaderboards, and feedback.	Survey	Motivation, engagement, and performance	Gamification increase learners' motivation, engagement, and performance.
Yaya and Kelvin (2016)	Examined the effects of gamification on students' learning of Mandarin language.	20 students / Language	Achievements and leaderboards	Survey	Concentration, skills, feedback, and immersion	Gamification had a positive impact on learners' concentration, skills, feedback, and immersion.
De-Marcos, Garcia-Lopez, Garcia-Cabot, et al. (2016)	Examined how gamification and social gamification can influence students' learning performance.	167 students / Multi-discipline	Points, achievements, and leaderboards	Survey	Performance	Students' performance was promoted with the use of gamification.
Poondej and Lerdpornkulrat (2016)	Explored the effects of gamification on students' engagement in a learning process.	577 students/ Multi-discipline	Points, levels, and achievement rewards	Survey	Engagement	Gamification significantly increased students' engagement in learning
Schreuders and Butterfield (2016)	Studied the effects of gamification on students' engagement, experience, and content coverage.	32 students / Multi-discipline	Points, levels, and progress bar	Mixed	Engagement, experience, and content coverage	Gamification had positive impact on students' engagement, experience, and content coverage.
Fleischmann and Ariel (2016)	Explored the effects of gamification on students' satisfaction and understanding of a course.	30 students / Medical	Challenges and feedback	Survey	Satisfaction and understanding	Gamification led the large majority of students to enjoy the learning process.
Filatro and Cavalcanti (2016)	Studied the effects of gamification on students' engagement.	54 students / Multi-discipline	Points, badges, and levels	Mixed	Engagement	Gamification increased student engagement in online learning courses.

Table B1: The Relationship between Certain Gamification Techniques and Students' Learning

Techniques/ Variables	Motivation	Engagement	Performance	Perceptions	Participation	Satisfaction	Attitude	Enjoyment	Competence	Understanding
Points	(Butler & Bodnar, 2017; Diniz et al., 2017; Kuo & Chuang, 2016; Roosta et al., 2016; Tan & Saucerman, 2017)	(Çakıroğlu et al., 2017; De-Marcos, Garcia-Lopez, Garcia-Cabot., et al. 2016; Denny et al., 2018; Poondej & Lerdpornkulrat, 2016)	(Çakıroğlu et al., 2017; Denny et al., 2018; Kim et al., 2016; Mekler et al., 2017)	(Aldemir et al., 2018; Aşıksoy, 2017; Piteira et al., 2017)	(Barna & Fodor, 2017; Özdener, 2018)	(Barna & Fodor, 2017; Fleischmann & Ariel, 2016)	(Piteira et al., 2017; Yıldırım, 2017)	(Tan & Saucerman, 2017; Wang & Lieberoth, 2016)	(Mekler et al., 2017; Sailer et al., 2017)	(Fleischmann & Ariel, 2016)
Badges	(Delello et al., 2018; Kuo & Chuang, 2016; Ortiz-Rojas et al., 2017; Roosta et al., 2016; Van Roy & Zaman, 2018)	(Filatro & Cavalcanti, 2016; Hegazy et al., 2017; Hew et al., 2016; Huang et al., 2018; Ortiz-Rojas et al., 2017)	(Balci et al., 2018; De-Marcos, Garcia-Lopez, & Garcia-Cabot 2016; Denny et al., 2018; Ortiz-Rojas et al., 2017; Rincon-Flores et al., 2018)	(Aldemir et al., 2018; Aşıksoy, 2017; De-lello et al., 2018; Piteira et al., 2017)	(Barna & Fodor, 2017; Özdener, 2018)	(Barna & Fodor, 2017)	(Piteira et al., 2017; Yıldırım, 2017)	N/A	N/A	N/A

Techniques/Variables	Motivation	Engagement	Performance	Perceptions	Participation	Satisfaction	Attitude	Enjoyment	Competence	Understanding
Leaderboards	(Balci et al., 2018; Bovermann & Bastiaens, 2018; Kuo & Chuang, 2016; Roosta et al., 2016; Tan & Saucerman, 2017)	(Ding et al., 2018; Ding et al., 2017; Hegazy et al., 2017; Hew et al., 2016; Suh et al., 2018)	(Balci et al., 2018; Çakıroğlu et al., 2017; De-Marcos, Garcia-Lopez, & Garcia-Cabot, et al., 2016; Kim et al., 2016)	(Aldemir et al., 2018; Aşıksoy, 2017; Piteira et al., 2017)	(Özdener, 2018)	N/A	(Piteira et al., 2017; Yildirim, 2017)	(Tan & Saucerman, 2017; Wang & Lieberoth, 2016)	(Mekler et al., 2017; Sailer et al., 2017)	N/A
Levels	(Butler & Bodnar, 2017; Diniz et al., 2017; Kim et al., 2016; Mekler et al., 2017)	(Filatro & Cavalcanti, 2016; Khalil et al., 2017; Poondej & Lerdpornkulrat, 2016; Schreuders & Butterfield, 2016; Suh et al., 2018)	(Kim et al., 2016; Mekler et al., 2017; Rincon-Flores et al., 2018)	(Piteira et al., 2017)	(Barna & Fodor, 2017)	(Barna & Fodor, 2017)	(Piteira et al., 2017; Yildirim, 2017)	N/A	(Mekler et al., 2017)	N/A
Rewards	(Ding et al., 2018)	(Ding et al., 2018)	N/A	(Aldemir et al., 2018)	(Özdener, 2018)	N/A	N/A	N/A	N/A	N/A
Progress bar	(Ding et al., 2018; Roosta et al., 2016)	(Ding et al., 2018; Ding et al., 2017; Piteira et al., 2017)	N/A	(Piteira et al., 2017)	N/A	N/A	(Piteira et al., 2017)	N/A	N/A	N/A
Challenges	(Van Roy & Zaman, 2018)	N/A	(Rincon-Flores et al., 2018)	(Aldemir et al., 2018)	N/A	(Fleischmann & Ariel, 2016)	N/A	N/A	N/A	(Fleischmann & Ariel, 2016)

Techniques/ Variables	Motivation	Engagement	Performance	Perceptions	Participation	Satisfaction	Attitude	Enjoyment	Competence	Understanding
Feedback	(Kim et al., 2016; Roosta et al., 2016)	(Kim et al, 2016; Thongmak, 2018)	(Kim et al, 2016; Thongmak, 2018)	N/A	N/A	(Fleischmann & Ariel, 2016)	N/A	(Thongmak, 2018)	N/A	(Fleischmann & Ariel, 2016; Thongmak, 2018)
Avatar	N/A	N/A	(Rincon-Flores et al., 2018)	N/A	N/A	N/A	N/A	N/A	(Sailer et al., 2017)	N/A

BIOGRAPHIES

Islam Alomari is a Ph.D. candidate at the Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia. Her research interests are educational technology and development, lifelong learning, and higher education.

Hosam Al-Samarraie is an academic member of staff in the School of Media and Performing Arts, Coventry University, UK. His background in Information Technology has influenced his work within digital technology, behavioral modeling, and design studies in a number of ways. His research areas are in Human-Computer Interaction, Digital Media, and Higher Education with emphasis on visualization, managing, clustering, and prediction of various interaction patterns. He is also interested in developing design guidelines for different user groups. His recent projects have focused primarily on the use of machine learning and multi-criteria decision-making methods to analyze, model, and predict aspects related to users' design preferences, user experience with technology, visual interaction, and usability testing.

Dr. Reem Yousef is an academic member of General Education Department, Al Falah University, Dubai, United Arab Emirates. She finished her Bachelor of Science in English Language & Translation from Ajman University of Science and Technology. Her M.A. and Ph.D. degrees were in English Language Education (TESOL) from University Science Malaysia where she received a Graduate Assistant Schema award from 2011 – 2014. Her research interests include TESOL curriculum theory, effective learning and teaching strategies in different learning contexts.