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Research paper

Gamification of Educational Technology: a Narrative Review

Muhamad Aldiansyah[1]*, Adam Amril Jaharadak[2],

School of Graduate Studies, Management and Science University, University Drive, Seksyen 13,40100 Shah Alam, Selangor, Malaysia
**Corresponding author E-mail:muhamadaldiansyah24@gmail.com*

Abstract

Student motivation and engagement are major problems in education. Gamification is one way to increase student motivation and engagement by combining game element in the educational environment. There are some empirical researches and review paper that has been conducted to give an evidence of gamification positive effect for educational technology but review papers that discuss practical suggestion have rarely been studied. This review is focused on papers that give an empirical evidence for gamification on learning in the context of narrative analysis to proposed best practices to do this research field. The study of gamification in educational technology is the basis this narrative literature review was made. Terms of search used is gamification, learning, student, engagement, motivation, and education. Gamification on e-learning that has no purpose on student motivation and engagement were excluded from the search terms. Fifteen papers were selected for review as they are relevant to the criteria. This review indicates that the use of game element has a positive influence on educational technology for the student, even there are various combinations for the chosen of learning activity, subject, game elements, method, sample size, and duration.

Keywords: *gamification; education; technology; learning; student; engagement; motivation*

1. Introduction

Student motivation and engagement are major problems in education [1], [2]. Motivation is known as possibly the main aspect which can be targeted to improve learning of the student [3]. Motivation, which answers the "why" of student behavior or action [4], [5] is considered a driving source for engagement [6]. Student engagement itself is can be defined as behavioral involvement and psychological investment in learning activities.

Learning is an activity all humans engage in their day-to-day life [7], [8]. One of the educational technology which is e-learning actually can be used to provide information and knowledge to increase learning opportunities and improve education efficiency [9], [10]. Furthermore, increasing motivation and engagement of students in e-learning can be achieved by gamification [11].

Gamification is defined as the use of game design elements in non-game contexts [12], [13]. Gamification has been commonly associated with points, levels, and leaderboards [14]–[16]. Current applications of gamification are based on providing external rewards for some activity. Gamification systems that focus on points, level, and leaderboard, badges, and achievements refer to BLAP gamification [17]. These attributes of computer game also can be implemented on e-learning system. There are actually many other elements that can be implemented.

The application of gamification to prototype education tools and online open courses is a prominent type of research in gamification [18]. The development of the internet usage can be used to spread the information [19]. There are review papers that have been published in purpose to investigate gamification in education. Those papers focus on educational contexts and game element that have been used in gamifying educational systems [1], identifying game design elements that have been used to gamify education as well as the impact on learner outcomes [20], shed light on the emergence and consolidation of gamification in education [21], and to shed a more realistic light by focusing on empirical evidence rather than on potentialities, beliefs or preferences [22]. Review papers that discuss practical suggestion has rarely been studied.

From 2014 until 2017, there are also further implementations. Due to the potential of gamification in education, this study differs from previous reviews by aims to investigate the current research of gamification for learning in terms of various gamification approach. Hence, the paper aims to report narrative analysis results, proposed the best implementation, and representation of present knowledge gaps. Potential implications for the design of gamification on educational technology and future research are subsequently discussed.

2. Methods

2.1. Paper Selection

Article search that relates to gamification, learning, student, engagement, motivation, and education on Google Scholar, IEEE, and Science Direct was performed. The papers search was limited in English, published from 2014 to 2017. This timeframe has been chosen for a reason. The reason is the necessity to analyze the current research and implementation of gamification that has been implemented in different approach in terms of learning activity, game element, and subject. The database search yielded a total of about 200 articles as of April 2018.

The abstract and title of paper retrieved were manually screened. Eligible paper to inclusion criteria was selected for the empirical investigations. Various further criteria to be incorporated into the review papers needed to (a) describe gamification which aimed to be used as a learning tool, (b) contain the element of quantitative or qualitative application evaluation, (c) year span from 2014 to 2017 and (d) include an abstract.

2.2. Data Analysis

This paper conducted qualitative–interpretive approach to data analysis. Following the general principles of qualitative data analysis, researchers first learn the data by reading from the selected articles then selectively attach meaningful tags to words, phrases, events, situations, and so on, naming that may important and distinguishing them from the rest of the data. Next, categorization was conducted and relationships between categories were determined. An analytic induction process was also conducted to reach interpretation. Finally, those categories were compared to modify and provide a potential implementation.

3. Results

3.1. Paper Selected for the Review

Using the criteria that explained, a total of 15 papers met the inclusion criteria and were recognized as significant to the present review. Both of studies describe some results concerning the effect of gamification for learning and therefore, were included in this review.
It was helpful to organize the 15 papers into categories based on the kind of aspect that related to the aim of the review, that the paper described: problem and purpose of gamification on learning; learning activity and subject of gamification on learning; and the game element of gamification on learning. These categories are shown in some table below, besides with the variety of papers in each area.

3.2. Problem and Purpose of Gamification on Learning

The researchers from the 15 selected papers conducted the research for a purpose because there is problem that want to be solved. In general, student motivation and engagement are major problem in education for learning. But there are also various specific problems that triggered them to do the research. Below is table for problem and purpose gamification research from 15 selected papers.

Table 1: Problem and Purpose of Gamification on learning

Authors	Problem	Purpose
[23]	Full student control over problem selection tends to be detrimental learning	Increase engagement and performance.
[24]	Studies with Quantified-Self (QS) applications in educational faces a lack of motivation	Increase motivation and enhance the user engagement.
[25]	Humans often compare themselves to other people when judging their own performance	Investigate academic performance.
[26]	Gamification of e-learning in information technology has been inadequately explored	Investigate performance
[27]	Necessity of other intelligent tutoring system to increase students motivation	Evaluate learning improvement
[28]	Lack of motivation causes students behave inappropriately and have lower performance	Investigates undesirable behaviour and increase student performance
[29]	Lack of engagement for data science and analytics software learning	Provide an educational environment for teaching data science and increase enjoyment
[30]	Dearth of comparison research for gamified and traditional environment effectivity	Investigate points element of learning on different environment.
[31]	Few number of student that interest to computer science and engineering	Rise the student interest using gamification
[32]	Few live human interactions for computer assisted language learning	Presents new methodology to assess gamification tools
[33]	Few classroom studies of gamification in the literature	Enhance student learning and motivation
[34]	Few studies about application of gamified engineering lab activity	Investigate gamification effects
[35]	Few of gamification Mandarin learning application in teaching.	Prototyping m-learning to increase user engagement
[5]	The lack of engagement in online discussions tool.	Investigate student motivation and engagement
[36]	Lack of interest in the process of Al-Qur'an memorizing	Increase the fun factor.

Based on the gamification of education research that has been selected, there are two main problems that can be recognized: lack of student motivation and a dearth of subject research. It can be seen that the main problem of education is lack of motivation, interest, and engagement. This is an evidence of student motivation and engagement are major problems in education [37], [2].
The dearth of research also can be triggered to drive researchers to do the research. For example, few comparative studies between traditional computerized application and gamification environment [30], few classroom studies on gamification [33], few lab activities application on gamification [34], and few language learning application on gamification [35]. It can be seen that comparison study between with and without gamification, classroom study, lab activity, and language learning are some of the problem that can be investigated further.

3.3. Learning Activity and Subject of Gamification on Learning

Learning activity and subject are also can be varied. Below is a table for some gamified activity.

Table 2: Learning Activity and Subject of Gamification on learning

Authors	Learning Activity	Subject
[23]	Assessment	Middle school mathematics
[24]	Mobile learning	-
[25]	Multiple choice question	Mathematics
[26]	Course	3D Modelling
[27]	Intelligence Tutoring Systems	High school mathematics
[28]	Multiple choice question	Middle school mathematics
[29]	Course	Introduction to Data Science
[30]	Assessment	Mathematics
[31]	Course	Microprocessors and Microcontrollers
[32]	Computer Assisted Language learning	Language learning
[33]	Multiple choice question	Physics
[34]	Multiple choice question	Engineering about Human Factor
[35]	Mobile learning	Mandarin Language
[5]	Online discussion tool	Education and Psychology
[36]	Mobile learning	Al-Qur'an Memorization

Based from the Table II, it can be seen that learning activity can be divided become 7 parts: assessment, mobile learning, course, intelligent tutoring system, multiple choice question, computer-assisted language learning, and online discussion tool. If look from the review paper that has been published, every subject actually could be implemented with gamification but there is might be still lack of empirical research for some subject. From this paper, mathematics, science, and language can be looked at three main categories.

3.4. Game Element of Gamification on Learning

Gamification can be defined as an effort to combine extrinsic motivation with intrinsic motivation in order to raise motivation and engagement for someone in an environment. The motivation that comes from within is intrinsic motivations where the user chooses whether to make an action or not, for example, love or aggression, competition, cooperation, altruism, sense of belonging. The motivation that comes from outside is extrinsic motivation, where something or someone determines the user to make an action, the examples are levels, classifications, badges, points, awards, missions [38]. Next thing that also can be varied is game elements that used in gamification. Below is a table for some game element.

Table 3: Game Element of Gamification on learning

Authors	Badges	Leader board	Level	Achievements	Points
[23]	✓				
[24]	✓	✓			✓
[25]		✓			
[26]	✓	✓			✓
[27]	✓				✓
[28]	✓				
[29]	✓	✓			✓
[30]					✓
[31]					✓
[32]	✓			✓	
[33]		✓		✓	✓
[34]	✓	✓	✓		✓
[35]		✓	✓		✓
[5]	✓		✓	✓	
[36]	✓		✓		✓

Based on the research on gamification of education that has been selected on this paper, there are actually five main game element that can be recognized: badges, leaderboard, level, achievements, and points. This is actually an evidence of some paper that state about badges, leaderboard, level, achievements, and points. According to Nicholson in 2012, gamification systems that focus on those five elements refers to BLAP gamification. Another study also states that points, levels and leaderboards form three of the most basic game patterns. It may be an easy, viable and, effective way to drive user behavior [39]. Also, according to Lu Ding in 2017, it recognized that badge is one of the favorite element that engages student [5].

Regardless of BLAP gamification, there is actually another game element that used on those papers. Those elements are: streaks, avatar, feedback, thumbs up, progress bars, and avatar. Between these game elements, avatar and progress bar are a common game element that used in the research. Avatar often appears close to the name of the user to highlight the person that using learning environment. For the progress bar, sometimes it is related to the level which means the progress to reach out the next level. This kind of element can be recognized have a role as extrinsic motivation to motivate and engage the student in using the learning environment.

3.5. Method of Gamification on Learning

There are environments that should be built to conduct an experiment through gamification on learning. After environment for learning activity and the subject is known, another thing that important is the method to get the result whether the gamification of learning that been conducted has a positive result or not. As mention in introduction that the paper should contain the element of quantitative or qualitative application evaluation. Below is a table for that information.

Table 4: Method of Gamification on learning

Authors	Method	Sample Size	Duration
[23]	Pre-post-test + Questionnaire	267 students in 6 groups	5 class periods (42 minutes per period)
[24]	Questionnaire	80 students in 2 groups	20 days
[25]	Score analysis + Questionnaire	80 women in 3 groups	1 week
[26]	Pre-post-test + Questionnaire	55 students in 2 groups	2 weeks
[27]	Log analysis	100 students in 4 groups	Unspecified
[28]	Score analysis + questionnaire	16 students in 2 groups	1 h
[29]	Log analysis + Survey	37 students in 2 groups	1 class period
[30]	Log analysis	1911 students in 2 groups	1 test session
[31]	Score analysis	120 students	5 years
[32]	Log analysis	Unspecified	6 months
[33]	Log analysis	2 groups	Unspecified
[34]	Log analysis	140 students in 2 groups	1 semester
[35]	Questionnaire	20 students in 2 groups	Unspecified
[5]	Questionnaire	54 students in 2 groups	8 weeks
[36]	Score analysis	15 students in 2 groups	Unspecified

From the data above, it can be recognized that this gamification of learning has 5 methods: pre-post-test, questionnaire, score analysis, log analysis, and survey.

The pre-post-test is actually the method that assesses the student performance before and after using the learning environment both gamification or traditional approach. The design of pre-post-test might be varied to some paper in the factor of a different number of question that given, different subject, different level of the subject, and different level of student that took the learning content.

There are some questionnaires to be used for measuring in general student motivation or student engagement. For example, the Intrinsic Motivation Inventory (IMI) that is used by [23], [28]. This questionnaire is a broadly confirmed instrument that can measure some factors associated with self-determination theory. It can be used to measure motivation after participants subjective experience with a system that interactive [40]. This questionnaire can measure the motivation into 4 categories: enjoyment, perceived competence, perceived choice, and pressure. Then, to measure the student engagement like [5], there is School Engagement Measure (SEM) that can be used [41].

A survey is conducted to get qualitative data from the student. For example, the researcher asks the feedback to the user that have been used learning content. The response might be positive or negative [29].

Score analysis and log analysis are actually similar. Score analysis attempts to analyze student performance based on the score, whereas log analysis attempts to analyze student performance can be based on the score or other value like the achievement of badges, the experience of using the learning content, or the time that spent to finish the task.

3.6. Finding and Gaps of Gamification on Learning

The researchers from the 15 selected papers finally got findings and gaps for research that conducted. Below is a table for problem and purpose gamification research from 15 selected papers.

Table 5: Finding and Gaps of Gamification on learning

Authors	Finding	Gaps
[23]	Re-practiced and no reward had the highest learning gains but using commercial learn-	Future studies should focus on progression through the game levels as an indicator of

	ing tool is more engage student	learning.
[24]	It has a positive effect on the motivation	The sample size was insufficient
[25]	Leaderboards in academic environments affects academic performance	Participants in did not receive feedback on their performance.
[26]	increase student engagement and achievement	The effects are greatly dependent to the learning context and characteristics of learners
[27]	Considerably correlation between points and learning but slightly correlation between points and learning.	It is necessary for other methods and scenarios to verify the correlation between gamification elements and learning
[28]	Improved performance and had positive motivational effect	Further investigations to experiment and gender issue
[29]	Improvement for submission rate, depth, and breadth of programming assignments	Unspecified
[30]	Speed of response increased with manipulation points condition.	This study was focused on one particular domain and type of questions.
[31]	Students improvement in average final grade	Unspecified
[32]	The introduced gamification adequately motivates users.	System is not a good fit for every user, since some people are very shy and cannot communicate with strangers.
[33]	Student significantly more engaged using gamified system	Task was not representative of the difficulty of the rest of the course.
[34]	It has positive effect of engagement	It should consider which game element had the greatest impact on student motivation, engagement, and performance
[35]	It has positive effect of engagement	Unspecified
[5]	Positive influence in student engagement	It is necessary for larger sample size, and a control group should be included to test the effectiveness of online discussion tool in a more solid way. It is necessary to find other indicators for measuring student engagement in online discussions.
[36]	Result of qualitative have shown good performance in the aspects of usability, fun, and ease of use.	Unspecified

Based on the result in Table V, it can be recognized that there are positive results in student engagement, motivation, and performance. This also can be an evidence that gamification is one process that can be used to resolve a major problem in education which is student motivation and engagement.

In another side, some specific game element is also investigated. First, re-practicing is one element that can be used to be implemented in learning content [23]. According to the autonomy theory of learning [42], re-practicing in learning actually gives students more freedom that could possibly enhance their engagement in learning. Their problem-solving skills also can be effectively trained. Second, the leaderboard is one element that can increase competition and stimulate social comparison [25]. Third, badges and experience points that can serve the purpose of watching, ranking and guiding the user, and also indicates how engaged a user is [43].

4. Discussion

This review is focused on papers that give an empirical evidence for gamification on learning in the context of narrative analysis to proposed best practices to do this research field. There are actually eight parts that must be prepared before conduct the research, there are problem, purpose, learning activity, subject, a game element, method, sample size, and duration.

It has been stated repeatedly that the major problem of education is student motivation and engagement but there is also subproblem that can be used for the reason to conduct gamification on learning research. From the Table 1, lack of student motivation and the dearth of subject research are two main problems that can be recognized and from this kind of problem, there are some learning activity and subject that further can be determined for a purpose. Some learning activity that has been recognized are assessment, mobile learning, course, intelligent tutoring system, multiple choice question, computer-assisted language learning, and online discussion tool.

Beside from the problem, analyze from the gaps is also can be used for further investigation. From this research, some gaps that can be recognized are proper sample size, specific game element investigation, the indicator for measure student engagement and motivation, progressive game level, representative task, and type of question. These gaps are possible to be investigated in the future research. If the problem is found, the purpose should be determined. Common purposes are motivation, engagement, or performance that want to be investigated, improved, enhanced, or increased.

Then, the game element should be chosen properly. Badges, leaderboard, level, achievement, and points are the common element that can be implemented. Combining game elements properly can make a difference to increase the motivation and the interest in the system.

To get the result, there are 5 methods for data collection which are pre-post-test, questionnaire, score analysis, log analysis, and survey. Sample size and duration are also should be determined properly.

5. Conclusion

In This review shows that recently from 2014 to 2017 the use of game element also has a positive influence on educational technology for the student, even there are various combinations for the chosen of learning activity, subject, the game element, method, sample size, and duration. Based from the variety of component that has been implemented, this review highlights the need to critically discuss and determine a benchmark for the design of game element, method, sample size, and duration then categorize it in some type of investigation.

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