

An Empirical Study of Gamification Impact on E-Learning Environment

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Abstract—Effective e-Learning requires students to be active, thus, creating an environment that engages the students is one of the challenges. One of the ways to build an engaging e-Learning environment is by applying gamification concept. It improves user engagement by enriching the system with the game design elements. This research aims to analyze the impact of gamification environment on e-Learning system by looking at student's quantitative interaction. 38 students from different high schools were voluntarily joined to test out two different system. This experiment focus on observing the impact of removing and adding gamification on the existing e-Learning system. The result shows that removing gamification causes significant decrement on student participation while adding gamification had no significant impact.

Keywords—e-Learning; Gamification; User Engagement; Human Computer Interaction.

I. INTRODUCTION

In the recent years, e-Learning becomes the solution to surmount the barriers of time and place in learning. The researchers have been working for years to improve the e-Learning effectiveness, making the e-Learning paradigm substantially changed, from teaching to learning [1][2]. It points out that e-Learning is not simply focusing on the needs of educating but it is more to paying attention on learning. These result to emphasize e-Learning as cognitive tool and emotional motivation tool which promote independent learning [3]. E-Learning should encourage students to become active learners and support the real class-like environment to encourage the participation. To accomplish this goal, the system should trigger more efficient and engage learning behavior [4].

One of the ways to build the engaging system is by applying the gamification concept. The main goal of applying this concept is to raise the user's motivation by improving the system engagement [5] and give the personalized fast feedback to user's activities [6]. That goal is supported by the fact that students learn more effectively when they are engaged and interested [7].

The purpose of this research is to discover the impression between e-Learning and gamification in case of raising user

engagement. This research will study the impact of adding or removing gamification from its existing system for each group by conducting it with online learning simulation, gathering the daily logs, and analyze the data quantitatively.

II. GAMIFIED E-LEARNING

A. Gamification Concept on Education

Gamification is one of the new evolutions on supporting user interaction on a system. The practices of gamification are well used in business or marketing, but the use of gamification itself has been varied to wider area and nudge in some fields of studies. Thus, bringing up the issue of proposing gamification in education is one of a break through to support the learning process.

Gamification denoted as “use of game design elements in non-game contexts” (Deterding et al., 2011)[8]. It is parts of gaming [4], which are represented as several interactions between actors and also requires active involvement of the players [9]. The avail of gamification in educational fields tends to be new experiential way to trigger student presence to make an achievement. With the gamification concept, the new way of learning is expected to be more challenging to the students and embroiled them to create an active learning.

B. E-Learning with Gamification

E-learning emphasizes the metaphor of participation. It points the learning process should be developed through collaboration and communication [1]. Although e-Learning is one of the new innovative solutions on education, it is still lacking on emotional interaction on the users. This concern point out the feeling of engagement through the system is not well perceived. Gamification on the other hands had the concept on creating users involvement and engagement through the system. Its main goal is to raise the engagement of users by using game-like techniques such as scoreboards and personalized fast feedback (Flatla et al, 2011)[10]. Combining gamification with e-learning will help creates learning environment which make the students feel more motivated, engaged and triggered to complete the task given.

According to "self-determination theory" from Deci and Ryan there are three needs of intrinsic motivation:

1) *Relatedness*

Relatedness defined as things that connected a person with their personal goals and their meaningful community of interest

2) *Competence*

Person interests on challenging task aiming to complete his/her goals.

3) *Autonomy*

Autonomy satisfies the need to control one's own life by taking part on voluntary play to fulfill their individual pursuit [11].

Nicholson [12] suggests that gamification can be used to improve these intrinsic motivations by making the game design elements used be meaningful for the users, this should be the students on our gamified e-Learning environment.

The idea of using gamification on e-Learning is presented as blending the game design elements on e-Learning system. The designs of the game element used for e-Learning are based on three design area [13]:

1) *Cognitive Area*

The gamifications on cognitive area designed focus on making complex system where students do the task gradually based on rules stated and utilize the system to complete the task given step by step to each level completion.

2) *Emotional Area*

As for the emotional area, the gamification elements are placed to create positive emotions on the students by including virtual reward for every completed task. These rewards raise the positive emotion that will lead the students feel they were improving and performing well.

3) *Social Area*

As for the social area, gamification elements planted to give competitive mechanism, for example leaderboard or ranking. This competitive mechanism is expected to motivate the students to improve themselves in order to gain social recognition.

Each of these game design elements has different effects to the students. In this research, we want to see how far the game design elements will impact the students. In this research the students are divided into two groups. Each one will experience different environment for two weeks. There are two environments that will be tested in this research.

Hereinafter, we interested on finding how will the gamification effect on student behavior for each group. Is there any significant influence on adding or removing gamification on e-Learning environment?

III. E-LEARNING SYSTEM DESIGN

A. *E-Learning Environment*

To simulate the e-Learning process, this research uses Moodle version 2.5.1. Moodle (Modular Object-Oriented

Dynamic Learning Environment) is one of the open source e-Learning systems that can be downloaded for free from its web page. It was built in PHP and support relational databases such as MySQL, PostgreSQL, or Microsoft SQL Server as well as Object-Oriented database like Oracle.

Moodle was developed primarily to help educators create online courses with focus on interaction and collaborative construction of content. It has several features considered typical of an e-learning platform, such as course page, discussion forum, calendar, file download, assignment submission, etc. Recent version of Moodle also support badges feature which is one of the gamification element.

We created two similar e-Learning environments with exact same design, system, material and facilitators. The only difference is one of the environment will be implemented with gamification elements. Two different groups of students will assigned into corresponding environment to see how they perform.

B. *Gamification Design*

The idea of implementing gamification concept on the e-Learning system is depend on the game design element used. This elements have the important role to create the effective e-Learning as well as to improve student's motivation throughout the process. There are five gamification elements chosen to be implemented on our e-Learning system. Those elements are leaderboard, score, title, badge, and completion track, as shown below.

TABLE I. GAMIFICATION ELEMENTS IN THE E-LEARNING SYSTEM

Gamification elements	Description
Score	Each student will receive score for their assignment performance and their various activities in the system
Badge	Students will be awarded with badges by completing various action that related with their activities
Leaderboard	Top ranked students will be displayed in leaderboard based on their scores and badges collected.
Title	Each student will get title based on their received score. The title presented in different levels and will be attached in their accounts name.
Completion track	Each student can see their own progress on the system, what task they finished, and what material they have viewed.

C. *Learning Curriculum*

The curriculum was created by considering some aspects which included the time, material and the respondents. The learning process were held within two weeks continuously. The learning materials were basic Java programming language, and the respondents were high school students.

TABLE II. CURRICULUM DESIGN

Day	Material	Task	Quiz	Forum
Day 1	Review of Java	√	-	√
Day 2	For Loop and Conditional Branch	√	√	√
Day 3	Logic Foundation	√	-	√
Day 4	User Interface	√	-	√
Day 5	First Week Review	-	-	√
Day 6	Quiz	-	√	-
Day 7	Weekend Break	-	-	√
Day 8	Array	√	-	√
Day 9	Array 2	√	-	√
Day 10	Debugging	-	√	√
Day 11	Java Class	√	-	√
Day 12	Overall Review	-	-	√
Day 13	Final Test	-	-	-

Table II shows the activities of the e-Learning simulation. Every day the students learn new material and discuss related topic in the forum. For practicing, the facilitators also prepare cases in the forum in order to deepen the student understanding about the material of the day.

IV. RESEARCH METHODS

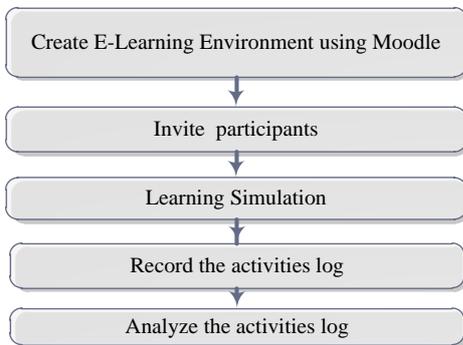


Fig. 1. Research Flow

Flow in Fig. 1 represents five main process of this research. In the first step, we create e-Learning system using Moodle as mentioned in previous chapter. Afterwards, the participants were selected from various high schools. Then the selected students perform the simulation in the e-Learning system for two weeks. All of the respondent activities within the simulation period were recorded in log files and analyzed by doing some text processing method.

A. Research Population

Thirty-eight high school students were voluntarily join to test out the gamified e-Learning. The participant’s age ranged

from 15 to 18 years old, with 24 male students and 14 female students. The participants were taken from the alumnus of Java Programming Workshop for beginner and from senior high schools that had passion in programming. Our assumption was these participants level of understanding about the learning material are similar.

The participants were divided into two classes to figure out the effect of gamification in e-Learning. The class A consists of 18 students while class B consists of 20 students. The participants were tested out with pre-test of basic programming to measure their knowledge and capability. Before taking a step to the real simulation, the research provide few days of trial use of e-Learning system. This is done due to familiarize the participants with the new system that will be used in this experiment.

B. Population Division

The experiment of the e-Learning systems held for two weeks. At the beginning of the experiment, the participants are divided into two classes and assigned into two different corresponding systems. After a week of experiment, the systems are switched for both groups. Therefore, every participant experienced two different systems in two weeks.

TABLE III. CLASS AND ENVIRONMENT DISTRIBUTION

Time	Class A	Class B
Week 1	Gamification Environment	Non-gamification
Week 2	Non-gamification	Gamification Environment

The measurement acquired by comparing quantitative aspects of the participants before and after the system was switched, as shown in Table III. The number of assignments, and discussion forum posted was same for each week in order to keep the data balanced. These two weeks data of student interaction will later used to analyze the impact of gamification on students participation.

C. Learning Process

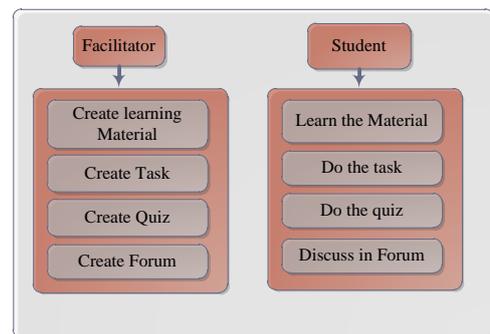


Fig. 2. Work activities based on roles within the learning process

As shown in Fig. 2, there are four main activities in gamified e-Learning environment where the facilitators and

students as the actors. Every day, the facilitators create and post learning materials into the system as well as the task of the day. And every three days there is a quiz to be done by the student. The facilitators facilitate forums for the students to discuss about the topic given on that day, and also trigger them with some cases related to the topic.

V. RESULT

This experiment concerns on quantitative values of student activities based on their logs in both groups. The log data consist of daily activities of each participant. We record each of participant activities which consist of their course view, assignment submission, discussion created, discussion reply and discussion view.

$$\bar{X}_D = \frac{\sum(R_1 - R_2)}{N} \quad (1)$$

Where:

\bar{X}_D : Mean of differences

R1 : Data record for the first week

R2 : Data record for the second week

N : Number of students

To see the impact of adding or removing gamification on e-Learning system, the data are summarized for each week to see the general differences. Mean of differences of each user activity record is as in (1) also calculated to indicate the significance for each of them.

TABLE IV. ACTIVITY RECORD OF CLASS A

Record	Total		\bar{X}_D
	Week 1 (gamification)	Week 2 (non-gamification)	
Course view	889	554	18.6111
Assignment submitted	40	38	0.11111
Discussion created	16	7	0.5
Discussion reply	246	239	0.388889
Discussion view	1530	1210	17.7778

TABLE V. ACTIVITY RECORD OF CLASS B

Record	Total		\bar{X}_D
	Week 1 (non-gamification)	Week 2 (gamification)	
Course view	552	630	-5.4
Assignment submitted	36	34	0.1
Discussion created	2	14	-0.6
Discussion reply	59	95	-1.8
Discussion view	439	683	-12.2

The student activity logs in both groups show that gamification gave impact on student participation in e-Learning system. As shown in Table IV, switching from gamification environment to non-gamification in class A decreased the number of participations and activities. On the other hand, class B data record shows increasing number of participations and activities after switching from non-gamification to gamification environment as pointed out in Table V.

To clarify the differences, two-tailed dependent t-test were used to check the significancy of gamification. The significancy level of 0.05 was picked for this experiment. The paired value is the difference between each activity log in first and second week of experiment.

TABLE VI. CALCULATED T-VALUE

Record	t value	
	Class A	Class B
Course view	2.44498	-0.499226
Assignment submitted	0.324946	0.270849
Discussion created	2.47386	-1.43105
Discussion reply	0.469126	-1.12709
Discussion view	3.02039	-1.07975

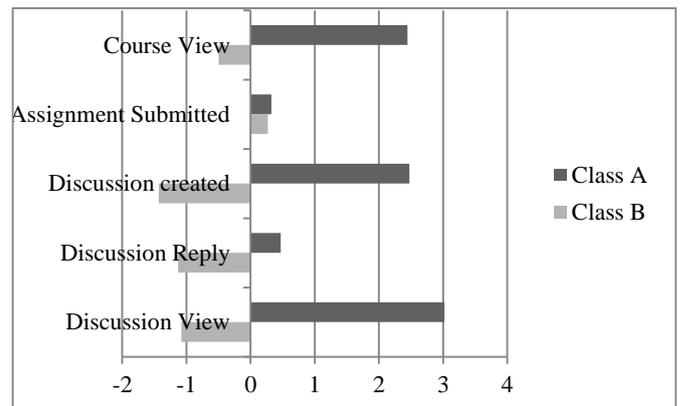


Fig. 3. t-value chart of each activity record of both class

The value in table VI and Fig. 3 represents the value of t for each recorded activities in class A. Based on t-distribution table, critical value of 2.1098 is acquired with significance level of 0.05 and 17 degrees of freedom. The figure shows that by applying gamification on first week then remove it on the second week causes significant decrement on the number of participation in course view, discussion created, and discussion view, as those t value is greater than the critical value.

The graph in Fig. 3 provides the value of t for each record activity in class B. With 19 degrees of freedom and significance level of 0.05, the critical value calculated as 2.0930. The t value of each activity record should be greater than 2.0930 to show it significantly decreased or it should be smaller than -2.0930 to be said as significantly increased.

Calculation of t value on each data record on class B show that even though it seems there are improvement by applying gamification on e-Learning system, none of t value calculated has exceed the critical value. Thus, it can not be claimed that it has differences to user participation by switching from non-gamification environment to gamification environment. The main reason is that even there are increasing student participation record, it only happened to a few students, hence make it no real differences in the participation level of the whole user from class B.

VI. DISCUSSION

A. Outcome Analysis

The behavior of the participants in the experiment shows that there are different outcome for both group while participating the learning process in the system. Both group shows change of behavior after environment switching, therefore by adding or removing gamification to existed e-Learning system causes change of participation level to some participants. Based on this experiment, removing gamification environment from existing e-Learning system causes more impact compared to adding it.

Experiencing conventional e-Learning environment on the first week points out to little participations. Thus, adding gamification on the second week turns out only affecting a few participants, as they already saturated by the conventional e-Learning system. On the other side, applying gamification on the first week causes many participants became interested with the system and encouraged them to be more active. This cause a lot of students enthusiast in the learning process on the first week. By removing gamification in the second week reduce their motivation factors, therefore making them not as active as in first week.

B. Obstacle and Challenge

As this research held, we face several issues that might influence the results of this experiment.

1) Technical aspect

There were some technical issues that might affect the result, for example some students had their PC broken and also difficulties on accessing the internet.

2) Environmental aspect

The differences of learning material that delivered in first and second week could take effect on student participation. Some of students claim the learning materials were too hard which make them have difficulties on following the discussion. While there are also phase that the students felt the learning material is interesting due to it is a new topic for them. Some students also claim that the user interface is needed to be fixed, although they find it easy to use it is still need an improvement on the design.

3) Participants aspect

Different personality of each participant may affect the result, as it influences the discussion and interaction of each people. Other issue we face on participant aspect that should be

noted is some of them cannot participate actively in a few days because of affected by disease. The daily activity of each student is also different, hence results in different available online time.

VII. CONCLUSION

As the result of the research showed above, it can be concluded that adding gamification on a non-gamified environment did not affect significantly on the students participation in the system. While on the other hand, removing gamification from a gamified e-Learning decreased the student's performance significantly. Although it give different result for both classes, the gamification itself had created the active atmosphere on the students for both environments.

The result denoted that gamification did improve student participation, but the role of facilitators cannot be eliminated to support this process runs effectively. Teacher or facilitator is needed to create dynamic interaction between learner and the teacher itself [1]. They have to accommodate and facilitate the needs of the students by being involved in the learning process, triggered them to be active, and give them some feedbacks. Gamification role in e-Learning system is only as a booster for the students, therefore facilitator is still needed to keep the learning process as real as class-like environment.

This research focused on quantitative aspect of gamification impact on e-Learning, therefore future work is needed to see the impact of gamification on qualitative aspect. Further research could be elaborated to view the impact of the external factors that might affect student motivation. It also noticed that this research scope is limited on high school students. Another experiment might needed on wider and more heterogeneous population as there might be different result applying gamification in e-Learning in different population.

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