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GAMIFICATION ANALYSIS AND IMPLEMENTATION IN ONLINE LEARNING

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Abstract. *Nowadays, there is a growing interest in e-learning, online learning that can be performed anywhere at any time. The gamification is integrated in some e-learning management systems, and it is expected to increase the students' satisfaction, motivation, and engagement. This study aims to evaluate the effectiveness of gamification in e-learning. For this purpose, an educational website, www.bangsacerdas.com, is established, where the survey is conducted for registered students. There are two parts of participants: the students who are directed to a learning system with gamification and the students who are enrolled in a learning system without gamification. During the process, the level of user engagement and the quality of learning are being evaluated in each group. The t-test results for these two populations suggest that there are significant improvements in the learning experience of the participants in the classes that implement the gamification in their system.*
Keywords: Online learning, Gamification, Student engagement, Quality of learning

1. **Introduction.** The development of Information and Communication Technology (ICT) has changed almost every aspect of our society. In the education sector, e-learning is introduced to offer the solution that the conventional method could not provide, which is the flexibility to learn from everywhere at any time. It breaks the boundaries of traditional classrooms and provides more opportunities for students to be well connected with tutors and classmates across worldwide [1]. The paradigm of conventional learning has changed. Now, learning could be done simultaneously from any different part of the world [2]. As the result, e-learning has grown into a new area of business, where educational institutions, both formal and informal compete to offer various options of e-learning courses.

As the conventional learning activities could be felt very monotonous [3], the same problem might also occur in e-learning as well. Numbers of researches are done to find the most effective methods to create more fun learning experience. One of them is gamification, a new platform that offers reward points to encourage students to engage more in the learning process. For instance, gamification is applied to the mechanical physics course by [4]. Simoes et al. have used the same method for teaching K-9 students [5]. Meanwhile, Perry has developed gamification in mobile learning to teach French [6].

Gamification has been widely developed and used to facilitate learning in many fields, levels, and aspects. However, [7] believed that most gamification softwares were doomed to fail because such software is exceptionally complicated involving various disciplines such as motivational and behavioral psychology, game design, and narratology. For instance, [8], from a study of 173 high school students, concluded gamification should be able to keep up with the learners growing abilities. [9] suggested that gamification should

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be carefully integrated into the existing learning instruction. Despite these issues, gamification had been demonstrated to improve third-grade students in writing participation, performance, and interest [10], to enhance students' empathy [11], to increase engagement and involvement of senior and junior physiotherapists and physical students [12], and to improve three aspects of learning math, namely, competitiveness, collaborativeness, and adaptiveness [13].

The outcomes of those researches mentioned above have only shown the increment in the user engagement, but not in their quality of learning. Nevertheless, a more in-depth and thorough analysis is needed to discover whether gamification platform is an effective investment for developing well qualified online learning.

Therefore, the purpose of this study is to examine the implementation of gamification in online learning and how it impacts the quality of the learning process. By comparing classes that have implemented gamification on their learning platforms with others that have not, the researches conclude that gamification provides the better result.

The remainder of this manuscript has the following structure. Section 2, Relevant Theories, presents the definition and the roles of gamification, and the online learning framework. Section 3, Research Method, presents the research hypotheses, the data collection method, and the statistical analysis. Section 4, Results and Discussion, shows the collected data, their analysis, and implications. Finally, Section 5, Conclusions, briefly presents the significant findings of the research and some potential research problems for future work.

2. **Relevant Theories.**

To set a cornerstone for a common understanding before constructing the research model, some related theoretical perspectives based on the results of the literature analysis are briefly described in this section.

2.1. **Online learning framework.**

Khan [14] has introduced the eight-dimensional e-learning framework, a detailed self-assessment instrument for institutions to evaluate the readiness and the opportunity of their e-learning classes to grow. The framework provides a solid structure to review the program systematically and to measure how the desired learning outcomes are achieved. It offers a practical and detailed checklist to serve the evaluation purpose.

There are eight dimensions in Khan's framework which are sometimes referred to as factors. Each dimension represents a category of issues that need to be considered in order to create a successful learning experience. These dimensions include institutional, management, technological, pedagogical, ethical, interface design, resource support, and evaluation [14]. Institutional refers to the administrative and academic part of the system. Management refers to the quality control, budget, and scheduling. Technological refers to the infrastructure, hardware, and software. Pedagogical refers to analysis, organization and learning strategies. Ethical refers to ethical, legal, and social and political influences. Interface design refers to the user interface, accessibility, and design content. Resource support refers to career services, journals, and online forums. Finally, the evaluation refers to the assessment of learners and educators.

2.2. **The definition of gamification.**

Modern gamification term was first introduced by Nick Pelling in 2002 [15]. Gamification is a concept that implements the game components into the non-game contents such as education, marketing, administration, or even software engineering [16]. These components include points, badges, leaderboards, and quests. Each of them serves the purpose to increase the level of user engagement in the learning process.

One of the successful applications of gamification is shown by the Devhub's announcement on August 2010, where it stated that there was an increment from 20% to 80% of users who have completed the online tasks by using this method [17].

As the result, the trend of gamification is growing rapidly. It has become a promising business, where based on the M2 Research report, gamification share market is predicted to increase from $522 million (2013) to $2.83 billion (2016).

2.3. **The role of gamification.** The gamification aims to increase the level of students' engagement because it has a positive correlation with the satisfaction, persistence and academic achievements that are really essential in order to achieve successful outcomes [18].

There are three components of engagement: cognitive, behavioral, and emotional [19]. Cognitive engagement refers to the students' effort to achieve a deeper understanding and expertise in the particular subject field. It is also closely related with the students' strategies to understand the concepts and use them in problem-solving. Behavioral engagement is related with the participation of students that could be shown in the positive conduct, the absence of disruptive behavior, and the participation in the class activities. Finally, the emotional engagement covers the relationship among students, tutors and academic institutions. It shows how active the students are involved in the class activities.

To achieve the purpose of the research, this study focuses on two components only: cognitive engagement and emotional engagement. Various gamified activities are provided to support all the learning process.

3. **Research Method.** The method of this study is to adopt the gamified learning strategy and combine the game elements with the well-designed e-learning activities. The goal is to determine whether gamification has a positive impact on online learning.

3.1. **Research concept.** This section introduces the design concept of our research, which implements the game elements into the system to facilitate the process of online learning. First, a learning environment is designed where the participants are able to sign in and follow the course according to their own flexibility. Then, the participants are divided into two groups: students enrolled in the specially designed class that has the gamification platform implemented in its system and the rest registered into the general class without gamification. The course subjects tested are Bootstrap and Microsoft Excel. During the studying process, the system records the parameters of learning activities, specifically in the duration of learning and the final score for each class. Finally, the result will be calculated and analyzed by using an independent t-test as the instrument and plotted on the boxplots. The research framework is shown in Figure 1.

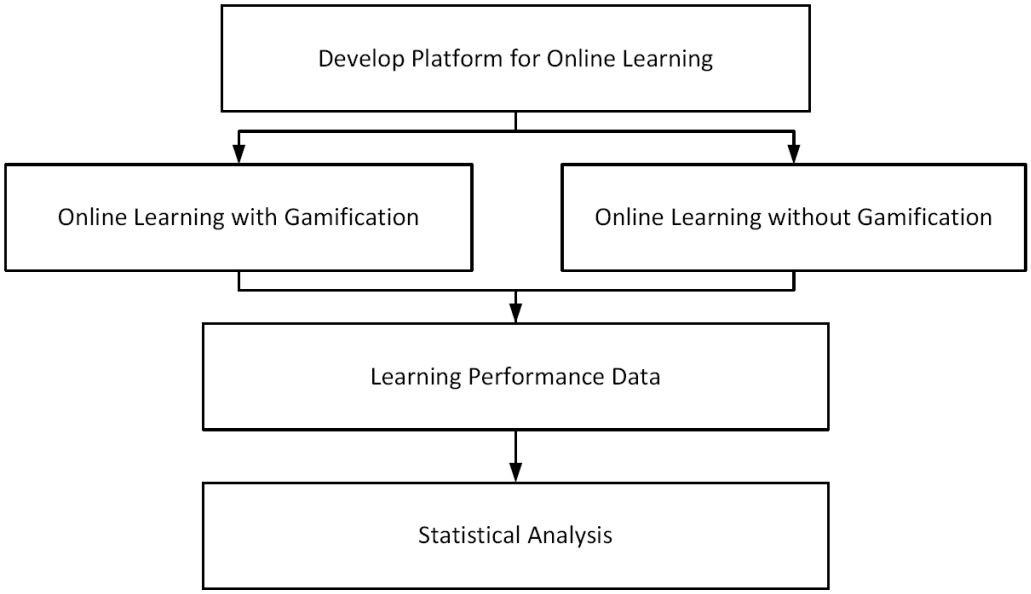


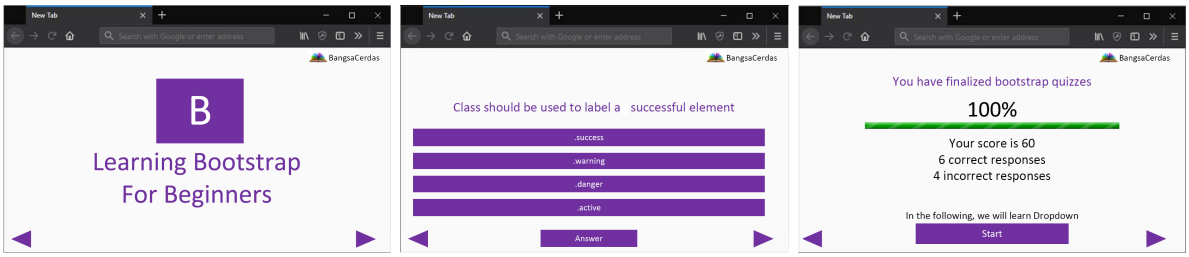
FIGURE 1. The research procedure

For the purpose of the research, two major hypotheses are described as the following.

Null Hypothesis: Implementation of gamification has a positive impact on online learning.

Alternative Hypothesis: Implementation of gamification does not have a positive impact on online learning.

3.2. **Design and implementation.** In the designed learning platform for this research, www.bangsacerdas.com, tutors are able to create and present their course materials in documents, slides, or videos format. They also provide the final tests to evaluate the participants' ability to understand the concepts and implement them into a problem-solving task. The sample of the materials is shown in Figure 2.



(a) (b) (c)

FIGURE 2. The screenshots of the online platform. (a) The starting page for learning Bootstrap subject. The statement reads "Learning Bootstrap for Beginners". (b) The class labels to represent the success level of participants. (c) The final page. It reads "You have finalized quizzes of Bootstrap subject. Your score is 60. 6 questions were correctly answered. 4 questions were incorrectly answered".

From the participants' perspective, they are directed to sign up to the class, follow the course, and do their best to learn the provided materials. Participants who enrolled in the specially designed class that uses gamification would have additional features on their dashboards that grant rewards for students who finished their task challenges. These rewards including points, badges, and rank could be seen on the leaderboard as shown in Figure 3. Meanwhile, the participants who enrolled in the non-gamification class would not have dashboards with the reward features.

Finally, to keep track of all of the data and activities, the system recorded the participants' activities since they had started the course until the end of the whole learning process, particularly in two parameters: the duration of learning and the final score. These parameters would be used in the data analysis to test the hypothesis.

3.3. **Participants.** The participants in this study are obtained by inviting students through the social media promotion. They are the students who enrolled the Microsoft Excel and Bootstraps courses on www.bangsacerdas.com, from the third week of February 2016 to the third week of April 2016, which reached the total number of 155 participants.

In detail, these 155 participants are divided into two groups: 30 students in Microsoft Excel subject and 125 students in Bootstraps subject, where each group contains two classes: the specially designed class that implements the gamification platform in its system and the general class without the gamification platform. From 30 participants enrolled in the Microsoft Excel subject, 15 of them are registered into the special design class with gamification platform and the remaining 15 students are registered into the general class. At the same time, from 125 participants who enrolled in the Bootstraps class, 62 of them are registered into the class with gamification and the other 63 are in the general ones.

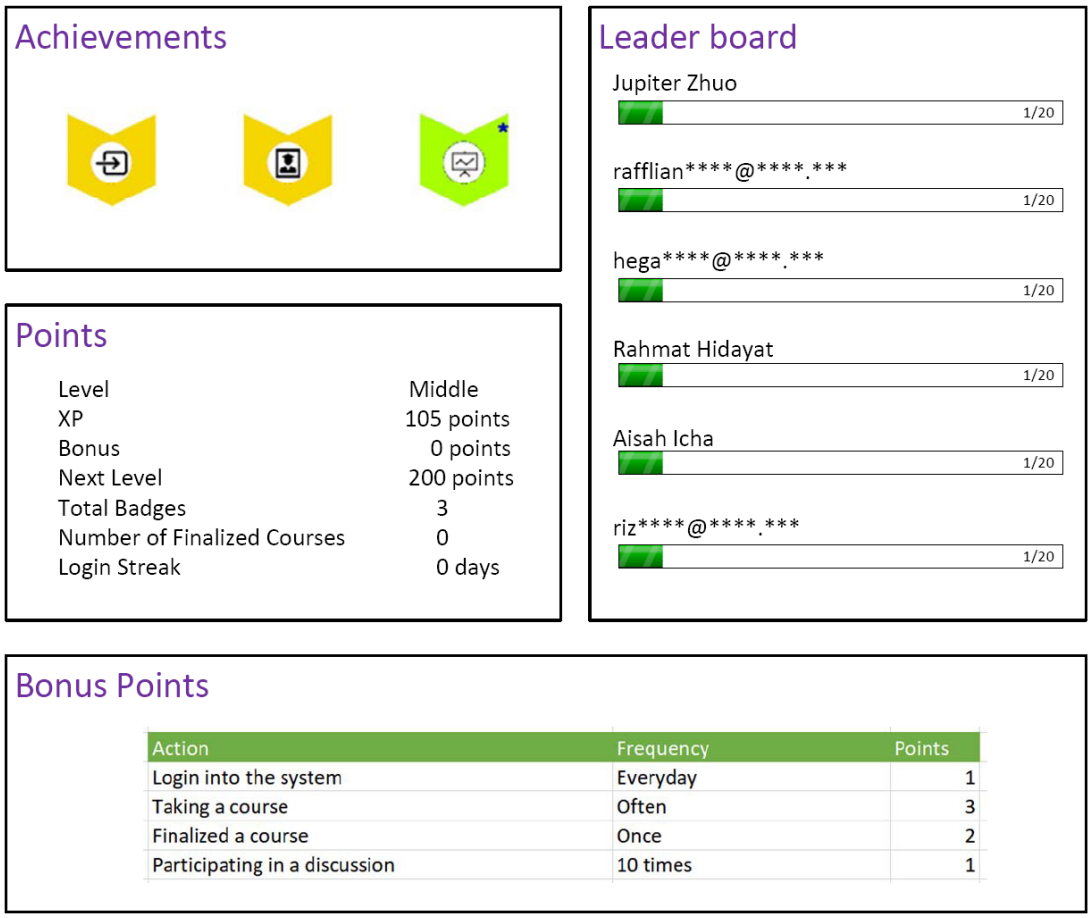


FIGURE 3. The elements of gamification

3.4. **Research instrument.** This study uses a t test for two samples to evaluate the difference between the means of two samples. The test assumes that the characteristics being studied are normally distributed for both populations. The null hypothesis of the test assumes that the means of the two populations are equal. On the basis of this assumption, we can compute the t statistic quantifying the difference between the two means by:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_1^2}{n_2}}}, \tag{1}$$

where μ, $\bar{x}$, s, and n represent the population mean, the sample mean, the sample standard deviation, and the number of data, respectively. The subscript 1 denotes the first population, and 2 is the second population.

By assuming all of the variances are equal, the test statistic can be simplified into:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}, \tag{2}$$

where s_p^2 is calculated by:

$$s_p^2 = \frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}. \tag{3}$$

The degree of freedom can be calculated by:

$$\mathrm{df} = n_1 + n_2 - 2. \tag{4}$$

The t statistic computed by (1) is considered significant if the associate p-value is smaller than the significance level α. The value of α is usually 0.05.

4. **Results and Discussion.** In the research process, the data are obtained in two forms, namely, the duration of learning and the final score for each participant. Then, those data are plotted on boxplots and error bars, and are used to calculate the t statistic. Eventually, the results of the test are analyzed and presented in this section.

Firstly, we start our discussion with the distribution of learning time data. The measured data are depicted in Figure 4. The figure shows the distribution of the raw data, the distribution in the form of boxplots, and the distribution in the form of error bars. The last graphical presentation shows the data mean and standard deviation. From the figure, we see that for the Bootstrap subject, the learning time data for gamification case are scattered twice as wide as for without gamification case. We also see that a significant overlap exists between those two datasets. The error bars also show the overlap.

For Microsoft Excel subject, the length of the overlap between the two datasets is less significant than the overlap in the Bootstrap dataset. In this case, the error bars slightly overlap. In the Bootstraps subject, the median value of the learning time data without gamification is 1572 seconds, and the median value with gamification platform has reached 2032 seconds, showing the 460 seconds of disparity. Likewise, in Microsoft

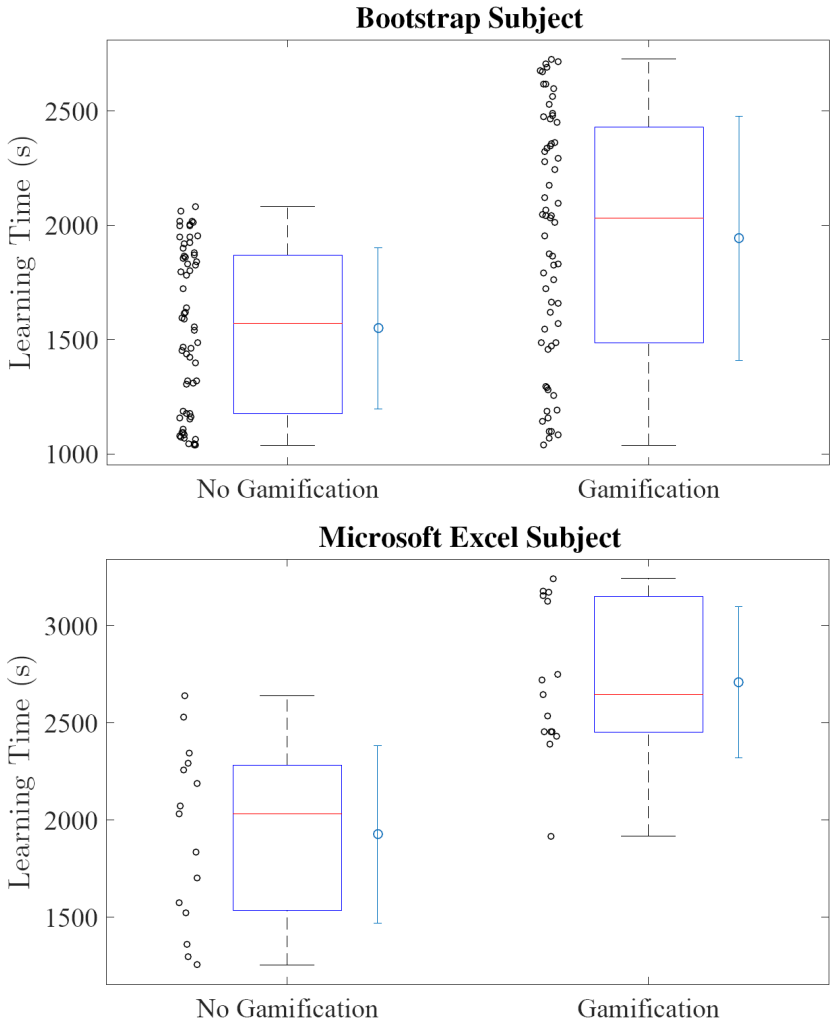


FIGURE 4. A comparison of the participants' learning time data for the Bootstrap and Microsoft Excel subjects with and without gamification. The error bar denotes the sample mean and the sample standard deviation.

Excel subject, the median value without gamification is 2032 seconds, and the median value with gamification platform has reached 2647 seconds, showing the 615 seconds of disparity.

By observing Figure 4, we are confident that, without performing a t test, for the case of Microsoft Excel subject, the mean of the learning time with gamification has increased from the condition without gamification. As for the case of Bootstrap subject, the conclusion cannot be easily made and should be postponed until the t-test results are available.

Secondly, we discuss the results of the t tests for the learning time data. The results are shown in Table 1. The statistical analysis decisively concludes that the means of the learning time with and without gamification are significantly different. We obtain t-statistic values of 4.854 (p-value $= 3.600 \times 10^{-6}$) for the Bootstrap subject and 5.052 (p-value $= 2.405 \times 10^{-5}$) for the Microsoft Excel subject. Both p-values are much lower than 0.05, concluding the existence of the significant differences in the means of the learning time with and without gamification.

Table 1. The statistics description of the participants' learning time in second for the Bootstrap and Microsoft Excel subjects and the results of the t test comparing the means of the learning time with and without gamification

	Gamification	Without Gamification
Bootstrap		
Mean	1943.3	1550.1
Variance	284433.6	124587.2
Observations	63	62
Pooled Variance	205160.1992	
Hypothesized Mean Difference	0	
df	123	
t-statistic	4.854	
p-value two-tail	3.600×10^{-6}	
t Critical two-tail	1.979	
Microsoft Excel		
Mean	2708.1	1927.0
Variance	151749.8	206788.4
Observations	15	15
Pooled Variance	179269.1	
Hypothesized Mean Difference	0	
df	28	
t-statistic	5.052	
p-value two-tail	2.405×10^{-5}	
t Critical two-tail	2.048	

Thirdly, we observe the participants' scores as depicted in Figure 5. The figure also shows the distribution of the raw data, the distribution in the form of boxplots, and the distribution in the form of error bars. The error bars contain the information of the data mean and standard deviation. Unlike the previous case, significant overlaps are observed; thus, it is not easy to conclude whether or not gamification improves the participants' score. In Bootstrap subject, the median value of the participants' scores without gamification is 6, and the median value with gamification platform has reached 8, showing the 2 points of disparity. Likewise, in Microsoft Excel subject, the median

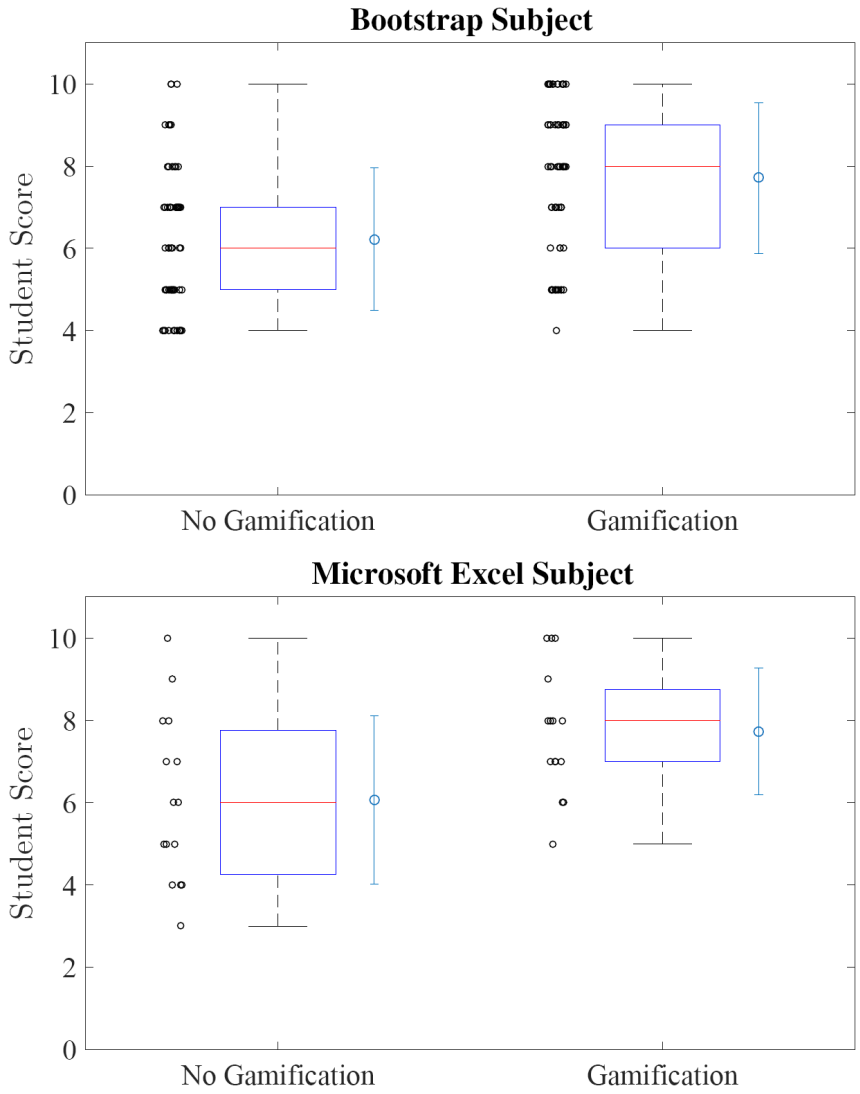


FIGURE 5. A comparison of the participants' scores for the Bootstrap and Microsoft Excel subjects with and without gamification. The error bar denotes the sample mean and the sample standard deviation.

value of the participants' scores without gamification is 6, and the median value of the class with gamification platform has reached 8, also showing the 2 points of disparity.

Lastly, we discuss the results of the t tests for the participants' score data. The results are shown in Table 2. We obtain t-statistic values of 2.520 (p-value $= 1.772 \times 10^{-2}$) for the Microsoft Excel subject and 4.663 (p-value $= 7.996 \times 10^{-6}$). These results indicate that the p-values are smaller than the significance level $\alpha = 5.0 \times 10^{-2}$, suggesting the differences of the means of the score data between with and without gamification are significant. Thus, we conclude the gamification improves the participants' scores.

5. **Conclusions.** This work investigates whether or not the gamification improves participants' learning performance. We measure the performance in the forms of the learning time and the summative assessment score. We establish a gamification learning platform and invite more than 100 participants to the platform to learn two subjects, namely, the Bootstrap and Microsoft Excel. The data of the two performance measures are collected and statistically analyzed. We conclude that improvements in terms of the means of the participants' learning time and score are visible and significant.

TABLE 2. The statistics description of the participants' score for the Bootstrap and Microsoft Excel subjects and the results of the t test comparing the means of the learning time with and without gamification

	Gamification	Without Gamification
Microsoft Excel		
Mean	7.7	6.1
Variance	2.4	4.2
Observations	15	15
Pooled Variance	3.3	
Hypothesized Mean Difference	0	
df	28	
t-statistic	2.520	
p-value two-tail	1.772×10^{-2}	
t Critical two-tail	2.048	
Bootstrap		
Mean	7.7	6.2
Variance	3.4	3.0
Observations	63	62
Pooled Variance	3.2	
Hypothesized Mean Difference	0	
df	123	
t-statistic	4.663	
p-value two-tail	7.996×10^{-6}	
t Critical two-tail	1.979	

As for the future work, deeper understand about how the elements of gamification affect the participants' cognitive process which are necessary. That particular work should be able to reveal the contributions of each gamification element to the learning experience.

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