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Gamification in e-learning: The Effect on Student Performance

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***Abstract*—The aim of this study is to analyze the effects of gamification elements such as points, level-up, badges and leaderboard in Moodle learning management system on students' performance. Forty-seven computer science students were participated in the online Computer Architecture course in two different settings. Students of the experimental group studied with gamification tools (points, level-up, badges and leaderboard) and students of the control group had access to the same content and activities without the gamification elements. The results indicated that students in the experimental group had higher grades than the control group students indicating a statistically significant difference regarding the students' performance on post-test scores.**

gamification; e-learning; performance; Moodle

I. INTRODUCTION

Education has become a great concern in societies, and many efforts have been made for more effectiveness and availability to learners in education. Traditional teaching techniques, such as the use of blackboards, lectures, books, and written exercises have been the main elements to transmit knowledge in the education. However, traditional education has been considered as inefficient and boring by many students, and as a result of this today's schools face huge problems about student motivation and engagement to learn [1]. Therefore, a different learning environment that is conducive to learning supported by information technology to assist students in obtaining and generating knowledge is required. The application of e-learning might be a solution to overcome the obstacles of effectiveness and motivation in learning. On the other hand, creating an effective and motivational environment in e-learning is one of the challenges that are encountered by educational institutions. In order to succeed in the era of e-learning, game-based approaches are some of the new opportunities that transform learning from the traditional perspective into a new, individualized learning experience [2]. In other words, the concept of gamification might be utilized to increase the efficiency, effectiveness, motivation, and satisfaction of students in e-learning.

The term "gamification" refers to the use of typical elements of game playing (e.g. point scoring, competition with others, rules of play) in the non-game contexts [3, p. 9]. Gamification as a rising trend has been recognized by many researchers and institutions as having a positive impact on motivation and performance [4], [5], [6].

The main purpose of this study is to investigate the effects of gamification in e-learning on learners' performance. In this study, the characteristics of gamification are combined with e-learning when creating online courses with the aim of reducing the rate of frustration and increasing motivation and performance during the learning process. Researches conducted in this area show that gamification may have a positive effect on students' participation in learning activities and their performance [7], [8], [9], [10]. So far, these studies mainly focused on the theoretical aspects and presented little statistical information on the potential advantage of the use of gamification in e-learning in computer science education field. Empirical data, therefore, are required to reveal any connection between gamified learning environments and students' performance in computer science education field. In this study, the effects of gamification elements such as points, level-up, badges and leaderboard in Moodle learning management system on students' performance are examined in the Computer Architecture course which is a course taken by junior students of Computer Science Department. The results of this study may contribute to literature by revealing the potential of gamification on learners' performance in Moodle e-learning environment in Computer Science field.

II. GAMIFICATION

This section presents the essential game elements and mechanics that are used in gamification. First, the concept of gamification, and game elements are covered, followed by an introduction of the tools of gamification in e-learning.

The first authenticated use of the term "gamification" occurred in 2000s and the term was simply known for the use of game design elements in non-game contexts [4]. Since then, the scope of gamification as a concept has been expanded and identified by others as follows:

- The operation of game thinking and mechanics to solve problems [3].

- The use of game mechanics and dynamics to enhance behaviors [11].
- The use of game mechanics in non-game environments such as marketing, employee training, and medical fields [12].
- The use of game mechanics, game thinking, and aesthetics to interact with people, stimulate action, enhance learning and solve problems [13].

The gamification of pedagogical concepts does not essentially involve a real game or information technology. Gamification of pedagogical concepts require the incorporation of design elements or patterns of activity commonly present in games into contexts of education in order to increase user participation in the performance various types of activities in a non-gaming context, especially if these activities tend to be considered uninteresting or routine [14]. This thinking puts the games on a different standard. They are not only tools for entertainment but also for inspiration, participation, and persuasion [13]. Gamification has recently been employed in several various areas [12], [15] in an effort to enhance the performance of employees in developing their daily tasks and work [16] and using gamification tools in e-learning [9]. Gamification has some common elements with behavioral learning theory, such as positive reinforcement, instant feedback, and progressive challenges. Educational gamification suggests that using the characteristics of games, such as systems of rules and/or a rewards system, have role in shaping the behavior of learners [17].

A. Gamification Elements

Games can be defined as "a form of play with goals and structure" [18]. In other words, a game is a system that has rules, content units, and the interaction components. Entertaining games offer interesting activities to users. Computer-supported gamified services are mainly designed to structure, support, and stimulate exercise activities [19]. All computer-supported gamified services include game elements that can be described as "elements that are characteristic to games" [20, p.156].

The game elements may be separated into two different categories, namely game mechanics and game dynamics [21]. Game mechanics are identified as varied acts, behaviors and mechanisms of control involved in gamified activity, such as points, levels, badges, virtual goods, leaderboards, and virtual gifts [21]. The game dynamics are defined as particular stimuli, which include rewards, ranks, achievements, individuality, competition, and altruism.

Table 1 presents the most widely used game mechanics and game dynamics, and the relationship between them. The columns represent the measure of human desires or emotions, which are basically the game dynamics. The rows represent the triggers of emotions, which are the game mechanics. In other words, game mechanics are the triggers or the causes, which would lead to emotions. It can be said that game mechanics act on the emotions or on human desire to push the player to perform various activities or produce results related to these emotions. Accordingly, if one or combinations of game mechanics are used in any learning environment, the corresponding human desire can be obtained. Therefore, it is possible to create a very motivational learning environment by using game mechanics.

TABLE I. INTERACTION OF BASIC HUMAN DESIRES/GAME MECHANICS AND GAME DYNAMICS [22]

Game mechanics	Game dynamics /Human desires					
	RW	***RN***	***AC***	***IN***	***CO***	***AL***
Points	★	O	O		O	O
Levels		★	O		O	
Challenges	O	O	★	O	O	O
Virtual goods	O	O	O	★	O	
Leaderboards		O	O		★	O
Gifts & charity		O	O		O	★

a. Abbreviations of Game dynamics/Human desires:
RW: Rewards RN: Ranks AC: Achievement IN: Individuality CO: Competition AL: Altruism

In Table 1, the star symbols represent which one of the human desires are primarily triggered with which one of the game dynamics, while the circle symbols show other possible human desires that might be affected by game mechanics. As an example, points are one of the gaming mechanisms and if a point is earned, the player feels rewarded, his/her motivation to get more points is triggered. Meanwhile, it might possibly affect the rank, achievement, and accomplishment type human desires. For example, when the player increases his/her points, he/she will move to the first or second level, thereby the player will rise in rank, which will trigger his/her emotions. Therefore, the use of these game mechanics in e-learning systems may lead to human emotions to trigger with far more engagement and fun, as opposed to a level of an excitement or stress. The most common elements in game mechanics (points, levels, badges/challenges and leaderboard) are explained below.

1) Points

Points game mechanics works by rewarding a user with points for completing certain actions. They can be used to drive desired behaviors, signify status in a course, and even unlock new learning stages or rewards. Most studies have found that points supplied immediate feedback, which in turn detected it to motivate students [4].

The use of points should occur in combination with other elements of gamification, such as levels and leaderboards in order to be efficient in motivating students [8], [23], [24]. Points are awarded in a wide selection of tasks, including completion of quizzes, attending lectures, participation in class exercises, solution of puzzles, creative thinking in assignments, completing practice questions, or correct answers [25]. Some researches showed that giving points was effective in increasing intrinsic motivation [25], [26].

2) Levels

Levels help learners understand when they have reached a milestone or a level of accomplishment. Levels can also be used as an opportunity to provide meaningful feedback and highlight areas for improvement and allow the division of a game into small pieces that are separated and accessible. Advancing to higher levels is usually a powerful stimulus for continuous effort [27], [28]. To implement the levels, users should earn points.

After obtaining a predetermined number of points, users move up to another level.

3) Badges

Badges are symbolic rewards given to students for "any kind of skills, knowledge, or achievement" that can be displayed to learners to "let others know their mastery or knowledge" [29, p. 218]. Badges help to motivate learners to do more, innovate faster, and work smarter than others. Challenges that are a somewhat difficult but meaningful for learners with visible recognition will motivate them to strive higher and work harder.

Badges introduce a social element to courses by permitting students to compete with other learners who are working towards identical goals [30]. If social participation is integrated into the curriculum, extra esteem of their achievements from friends and family are achieved [30]. Learners generally granted access for reviewing badges they have and check the demands for gaining new badges [30]. It was also found that students feel gratified for carrying out their homework and expressed additional appreciation when they were awarded with a badge for their achievement [31].

4) Leaderboard

The leaderboard is one of the most widely used elements in gamified applications. They are basically scoreboards that display progress and arrange (mainly in a descending order) learners to help them measure their performance against their peers. For competitive students, leaderboard provide immediate feedback and allow learners to constantly attempt to improve their rankings. A leaderboard generates contest and a feeling of being among a group with similar thinking while allowing learners to compare their performance with another students' performance [25]. Leaderboards may depend on (a) the points system, (b) the number of achievements made by learners, or (c) the progress of the learner towards a final goal [8]. This allows learners in spending all their time comparing their accomplishments with others without letting anyone else know "that they are constantly involved in such a social comparison" [31].

B. Gamification with e-learning

The gamification concept creates participation of students through the educational environment in order to increase their motivation by using game techniques such as scoreboards and immediate feedback [8]. Combination of e-learning and gamification will assist to create a studying environment that makes learners feel more stimulated and involved to accomplish the assigned task.

Games usually allow players to restart or play once more, making recoverable errors. This freedom of failure permits students to have experiences without fear, thereby increasing student participation [7]. The core of gamification in e-learning is beyond the technology. It has psychological basis aims to increase stimulus and access to higher levels of participation in the learning process. Well-designed game environments provide continuous opportunities for player improvement, large amounts of feedback, and very complex tasks for each individual to solve alone as well as environments that change in response to learners' actions [7]. The researchers have also concentrated on using gamification to enhance participation has been to find methods to stimulate students to engage more with the core theme of learning [32]. Attention is focused on increasing participation in training, education in general and various classroom activities and e-learning platforms.

III. METHODOLOGY

In this section, the methodology behind this study is presented. The first part presents the research question, the second part describes the design of the study along with participants and procedures, and the third part explains the implementation of gamification techniques in Moodle learning management system.

A. Research Question

The following research question guided this study:

What is the effect of gamification tools (points, level-up, badges and leaderboard) in the Moodle e learning environment on learners' Computer Architecture course performance?

B. Design of the Study

The main goal in this study is to combine the characteristics of gamification tools with e-learning and to examine the effects of using gamification tools (points, level-up, badges, and leaderboard) in Moodle system on learners' performance. In this study, pre-test, post-test experimental research methodology is used as shown in Figure 1.

The experiment of using gamification tools in Moodle e-learning system was held for three weeks. The participants of the study were 70 junior students from Computer Engineering Department at Wasit University in Iraq. Their age ranged from 20 to 25, and there were 38 male and 32 female students. The participants were assigned randomly into two groups (35 students in each group) to enroll in online Computer Architecture course in Moodle system with or without gamification tools. At the beginning of the study both groups were examined with pre-test on paper. There were 25 multiple-choice questions in the test. The randomized version of the same test was examined as post-test at the end of the study. 47 participants (30 in experimental group and 17 in control group) regularly followed the online course materials. Therefore, only the students who attended online Computer Architecture course were included into analysis in order to compare their knowledge of the Computer Architecture course and to determine how gamification tools (points, level-up, badges and leaderboard) in Moodle system affected learners' performance.

The students' scores of the pre- and post-tests were subjected to statistical analyses in a SPSS statistical program by using independent two sample t test (two-tailed) to evaluate whether there is a significant difference between the mean values of the experimental group and mean value of the control group or not. The following hypothesis were formulated:

H0: There is no statistically significant difference between the experimental and control groups regarding the students' performances on test scores.

H1: There is a statistically significant difference between the experimental and control groups regarding the students' performances on test scores.

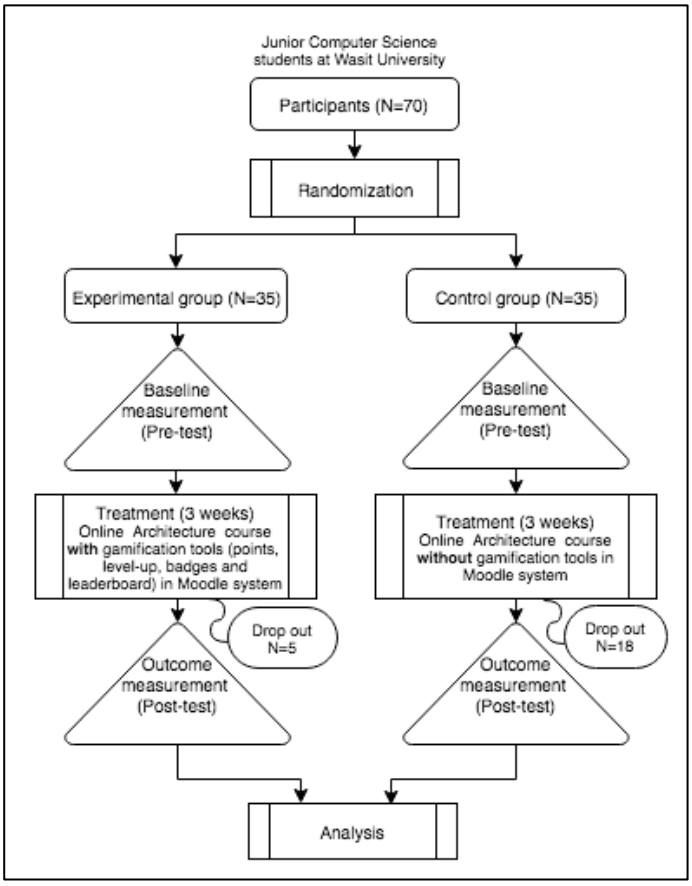

Figure 1. Design of the study

C. *Implementing Gamification Techniques in Moodle*

In this study, Moodle version 3.3.2 was as a learning management system. The Modular Object-Oriented Dynamic Learning Environment (Moodle) is one of the popular open source e learning managements systems, and can be downloaded freely. Moodle has many features which are common for an e-learning management system, including file uploading, calendars, courses pages, forums for discussion, submission of assignments, progress track, quizzes, etc. The gamification elements were added in the form of plugins, as they were not available in the core of the Moodle 3.3.2 system. Two different courses in Moodle system were created: (1) Experimental group course- Computer Architecture course in Moodle system including gamification tools; (2) Control group course, Computer Architecture course in Moodle system with the same content and without gamification tools. The students in each group could access only their group's course.

In each course, there were 3 chapters at 3 weeks. Each chapter included assignments and quizzes. For experimental group environment, four gamification elements (points, level-up, badges and leaderboard) were used. These gamification elements are explained below:

1) Points: Each student earns points for their submission of assignments and quizzes in each chapter in online Computer Architecture course.

2) Level up: Students proceed to certain levels whenever they gain a certain predetermined number of points (see Figures 2 and 3).

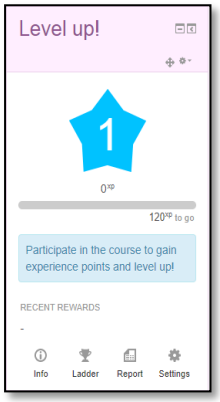

Figure 2. Level up element

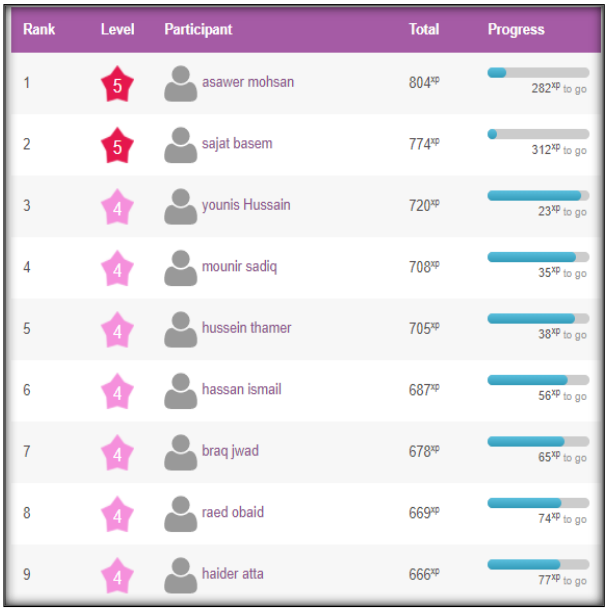

Figure 3. Students move up to a certain level when they gain a certain a number of Points

3) Badges: Students are awarded with badges by completing several actions related to their activities (assignments and quizzes). Two badge categories were prepared in this Moodle system:

a) As shown in Figure 4, students are awarded "Assignment Completer" badges when their answers in assignments of each chapter are correct.

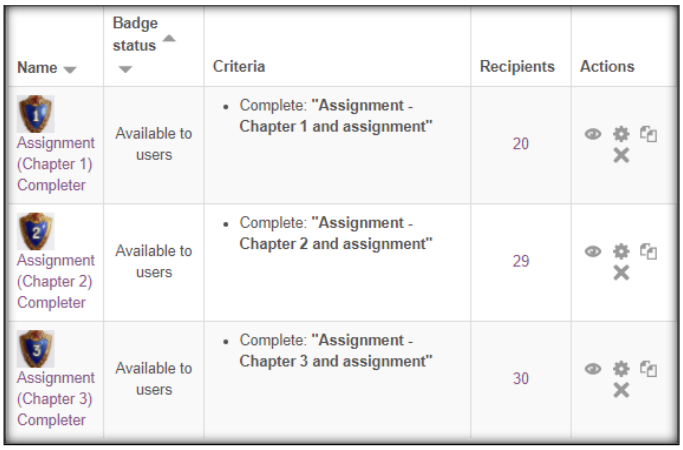

Figure 4. Badges (First Category) element in Experimental Group Environment

b) As shown in Figures 5 and 6, students earn "Gold Cup", "Silver Cup", or "Bronze Cup" badges according to their scores in quizzes. For example, the students earn a Gold Cup if a student's score is over 90% in the test, a Silver Cup if a student's score is between 80% and 89%, and a Bronze Cup if a student's score is between 70% and 79% in the quiz.

Figure 5. Badges (Second Category) element in Experimental Group Environment

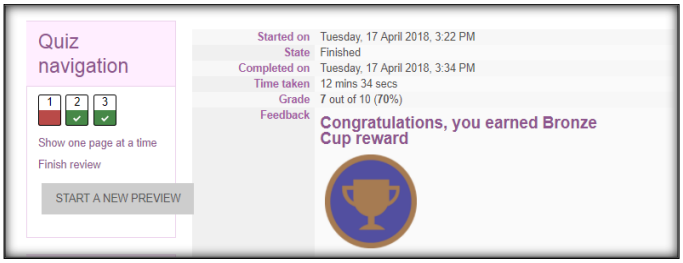

Figure 6. When the students earn Bronze Cup in Experimental Group Environment

4) Leaderboard: The top-ranking students are displayed in the leaderboards based on their points and collected badges (see Figure 7). To make the participation more competitive, the leaderboard is shown to students in every week when they completed assignments and quizzes in each chapter.

Figure 7. Leaderboard element in the Experimental Group Environment

The online Computer Architecture course covered the topics that were in traditional face-to-face classroom sessions, and the students of experimental and control groups were prompted to use online course materials completely alone in their home through three weeks.

IV. RESULTS

The t test was performed to compare the achievement scores of the experimental and control groups. The t test is a parametric test to evaluate whether the means on a test variable differ significantly between two groups. The data collected were entered and analyzed by using the SPSS program. The results of the t test for the pre-test are presented in Table 2. As shown in Table 2, in terms of the pre-test scores, the t test revealed no significant mean difference (t = 0.130 and t critical two tail = 2.014) between the achievement of the students in the experimental group and the students in the control group. Since the t stat (0.130) is smaller than the critical value of the two tail value (2.014) at the 95% confidence level, the mean of the experimental group and the mean of the control group were equal with respect to the students' knowledge about the Computer Architecture course at the beginning of the study.

TABLE II. RESULTS OF THE T-TEST FOR PRE-TEST

Pre-test t-test results	*Experimental group*	*Control group*
Mean	32.933	32.471
Variance	156.340	105.765
Observations	30	17
t-stat	0.130	
P(T ⩽ t) two-tail	0.897	
t-Critical two-tail	2.014	

As in Table 4, in terms of the post test scores, the t test reveals a statistically significant mean difference (t = 3.215 and t critical two tail = 2.014) between the achievement of the students in the experimental group and the students in the control groups. Since the t stat (3.215) is greater than the critical value of the two-tail value (2.014) at the 95% confidence level, the experimental group and the control group had statistically significant difference on students' post-test scores. Therefore, we rejected hypotheses H0 and accepted hypotheses H1, indicating that there is a statistically significant difference between the experimental and control groups regarding the students' performances on the post-test scores.

TABLE III. RESULTS OF THE T-TEST FOR POST-TEST

Pre-test t-test results	***Experimental group***	***Control group***
Mean	54.000	39.765
Variance	198.345	238.941
Observations	30	17
t-stat	3.215	
P(T ⩽ t) two-tail	0.002	
t-Critical two-tail	2.014	

In summary, the above results reveal the significant positive effects of gamification tools on students' learning when an instructional environment is embedded with gamification tools, such as points, level-up, badges and leaderboard.

V. CONCLUSIONS

This study used the experimental research procedure to examine the effects of gamification tools (points, level up, badges and leaderboard) on students' learning in two separate and equivalent groups of computer engineering students who were engaged in equal core learning materials of the online Computer Architecture course in two pedagogically different environments in the Moodle system, that is, using gamification tools (points, level up, badges and leaderboard) in the Moodle system for the experimental group and without gamification tools in the separate environment in the Moodle system for control group. At the beginning of the study, 70 students from the experimental and control groups were subjected to a pre-test of prior knowledge. A total of 47 students (30 students from the experimental group and 17 students from the control group) attended the online Architecture course for three weeks. At the end of the online Architecture course, 47 students from the experimental and control groups were examined in a post test.

To answer the research question, the t test was employed to compare the mean results of the achievement scores of the 47 students of the experimental and control groups in the pre- and post tests according to the hypotheses. The pre-test results show that students in the experimental group had no statistically significant difference from the control group regarding students' performances. On the other hand, on post-test scores, the experimental group got statistically significant higher scores in comparison to the control group. It can be concluded that the students in the experimental group using the gamification tools of the online Computer Architecture course were significantly more greatly motivated to access and use the online learning material than the control group. These results are compatible with previous results [7] [8] [9] [33].

Finally, if the gamification elements such as points, level up, badges and leaderboard are effectively integrated into online courses to motivate students and promote learning, it might lead to better results in terms of attendance and performance. Based on our study, there was a higher attendance level, a higher amount of submitted homework and an improvement in the grades in the post test scores obtained by the students in the experimental group. The gamification features having their own power to increase students' performance in the learning process can explain this, and at the same time, could be the reason for the decrease in drop outs of the majority of students in the experimental group to attend the online Computer Architecture course. Therefore, the teachers need to be able to begin to incorporate mechanisms of gamification into their teaching practices.

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