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Intervention Strategies through Interactive Gamification E-Learning Web-Based Application to Increase Computing Course Achievement

Noor Zuraidin Mohd Safar ^{a,*}, Hazalila Kamaludin ^a, Masitah Ahmad ^b, Muhammad Hanif Jofri ^c,
Norfaradilla Wahid ^a, Taufik Gusman ^d

^a WEST Focus Group, Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, Batu Pahat, Johor, Malaysia

^b Faculty of Information Management, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Rembau, Malaysia, Kg Pilin, 71300, Rembau, Negeri Sembilan, Malaysia

^c ICAN Focus Group, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Muar, Johor, Malaysia

^d Department of Information Technology, Politeknik Negeri Padang, Sumatera Barat, Indonesia

Corresponding author: *zuraidin@uthm.edu.my

Abstract— This study aims to help students improve their knowledge capability based on their active participation through gamification. Gamification is one of the newer methods of education that has the potential to improve student learning. This research looked into gamification's efficacy in student engagement and learning retention during teaching and learning sessions for computer science or information technology courses. The assessment involved in this study is through Pre-Test and Post-Test through instructional intervention by adapting interactive Quizizz gamification e-learning web-based application. The flow of research works begins with a survey of the problem, pre-intervention analysis, and action was taken during the intervention, ending with the implementation and observation phase. The pre and post-analysis of test results and questionnaires were accomplished and discussed. Fifty-six respondents participate in this study. Results show that 87% of the respondents have increased their percentage of marks. In the pre-test result, 56% of the respondents achieved below the 55 marks, while in the post-test, it reduced to 14%. Adoption of other gamification applications, a larger target demographic, and the addition of computer science or information technology courses will help improve the study in the future.

Keywords—Instructional Intervention; intervention strategy; e-learning, gamification; information science.

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I. INTRODUCTION

This study aims to help information technology students improve their acquiring knowledge based on their participation that will influence their assessment by adapting gamification as part of the learning tools. Gamification is one of the newer methods of education that has the potential to improve student learning. This research looked into gamification's efficacy in student engagement and learning retention during teaching and learning sessions [1], [2]. Although there are various challenges in the handling of gamification, and the response from students is quite unsatisfactory, the study by Sánchez-Mena and Martí-Parreño [3] has shown an improvement in students' mastery of knowledge.

The assessment involved in this study is through Pre-Test and post-test of instructional intervention by applying interactive gamification e-learning. One lecturer and all fifty-six students in the specified two sections of classes were directly involved in this research. The gamification used in this study is Quizizz [4]. Quizizz is a free gamification web-based application selected in this study [5]. The study of analyzing pre-tests and Post-Test will determine the outcome of this study. The research implementation process begins with a survey of the problem, pre-intervention analysis, action taken during the intervention, and ends with the implementation and observation phase.

Gamification is the use of game elements in non-design games [6]. Gamification is also considered a new tool in active learning to increase student engagement and interest, primarily improving knowledge retention [7]. In addition, the

gamification approach can affect students' learning achievement and psychological and behavioral changes [8]. In education, gamification is not meant to build one new game or create custom applications but only by applying the gamification process to selected learning [9], [10]. Gamification has been shown to increase learning outcomes in the classroom by adopting features in various elements in digital format [11]. Recently, the elements that are often used in the development of gamification are as follows:

A. Points System

A Point system is used to collect points when the player successfully passes the level of the game provided [12]. Among the point systems used are earn and burn; earn allows students to accumulate points when a given assignment is submitted before the set date, and Burn will reduce the accumulation of points when students do not submit or submit beyond the set date.

B. Achievement Badge

A badge is a form of feedback and proof of student achievement. Implementation of granting badges needs to be wise and in a meaningful way to make students appreciated. Badges will be given to students after students complete some challenges that are met the criteria of the badges [13]. In online classrooms where gamification was integrated, the badges were given to students who had a certain number of logins, completed assignments, submitted assignments with no mistakes, had a certain amount of daily engagement, completed challenges, and were at the top of their class and platform [14].

C. Level of Development

The level of development is a progression level of skills and knowledge based on the player's mastery scale, for example, from easy to more difficult levels. This level of development can be displayed in progress bars, icons, or metaphors such as bronze, silver, gold, and platinum [15].

D. Quests or Challenge

A quest or challenge allows players to overcome obstacles in the game within a given time limit [16]. It aims to see if the player can overcome the obstacles and difficulties that have been set.

E. LeaderBoards

Leader Boards aim to make comparisons between players participating in the game [17]. Usually, the list of participants will be displayed in the list of players along with the scores owned and arranged according to the position of the players. A learning approach that uses this method of play rather than rendering the learning process is more interesting and interactive, and it also makes the activity that it was originally not a game as a formal and serious play activity [18]. This is supported by a study conducted by Karakoç et al. [19] that explains that gamification-based teaching practices positively impact achievement and students' attitudes toward lessons. Integrating gamification in education can also help overcome diversity problems [20]. Thus, the gamification approach can be defined as the element integration of games into learning methods to make learning sessions more interactive.

II. MATERIALS AND METHODS

A. Research Focus and Objectives

This study involved 56 respondents that registered for Web Application courses for Semester 1 in the 2020/2021 academic session. The Web Application course is offered by the Computer Science and Information Technology Faculty at Universiti Tun Hussein Onn Malaysia. This study will focus on teaching and learning strategies used to address the issue of students not being interested in Web Application courses. Various efforts were made to stimulate students' interest. This is the most important initiative that will encourage students to study with full diligence and, in turn, will trigger an improvement in students' performance in their quizzes, tests, and final examination. Preliminary findings show that students cannot focus consistently when the lecturer delivers the teaching and learning process. Thus, this study is to evaluate the extent to which the strategies used to have an impact on overcoming the problem of students not being interested, not having fun, not having a high desire to work, and being passive during teaching and learning.

The research aims to improve students' assessment results through intervention strategies by engaging interactive e-learning web applications and mobile applications such as Quizizz. In order to achieve the research's aim, the following objectives need to be aligned and followed:

- To analyze students' outcomes before adapting instructional intervention.
- To apply user-friendly interactive e-learning web applications for students to compete positively through gamification concepts [25] and competition during class sessions.
- To analyze students' ability to interact and respond appropriately in actual assessment.
- To compare students' outcomes after adapting instructional intervention.

B. Reflection on the Previous Teaching and Learning Process

Throughout the learning and teaching process, the instructor often asks questions to ensure students understand the lesson's content during class hours. However, some students said that they are not feeling excited about learning Web Applications. They want more than what is described as the usual traditional one-way or two-way communication routine in a traditional classroom environment [21]. They are hungry for teaching and learning that is more fun, cheerful and competitive [22]. In addition, students cannot remember the important facts that have been presented [11], [23]. Students' feedback in random situations typically approximates such as "I am not interested," "I want more fun during class hour", "I cannot focus for a long time," and "I quickly get bored". Those replies from students are very worrying because the Web Application course also requires students to remember important facts to answer questions in tests and examinations. After delving into the students' problems, it is indicated that they also could not focus consistently while the instructor was lecturing. Diversity in the teaching and learning approach is very important to help them gain interest and fun while studying this course [24].

C. Research Materials and Methodology

This section will outline the research process, beginning with the target group, research methodologies, and data collecting.

1) *Target Group*: This study involved 56 students/respondents who registered for Web Application courses for Semester 1 in the 2020/2021 academic session, as depicted in Fig. 1 and 2. They consisted of 30 female respondents and 26 male respondents. Web Application course is offered at Computer Science and Information Technology Faculty at Universiti Tun Hussein Onn Malaysia.

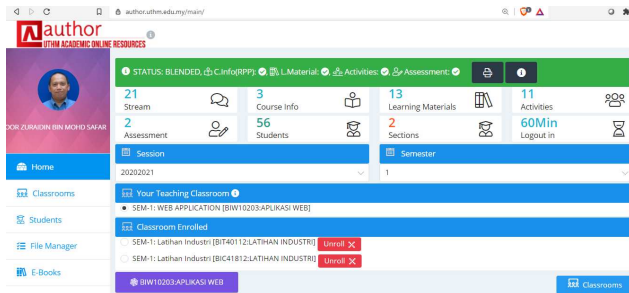


Fig. 1 Fifty-six students from two sections registered Web Application course for Semester 1 in the 2020/2021 academic session.

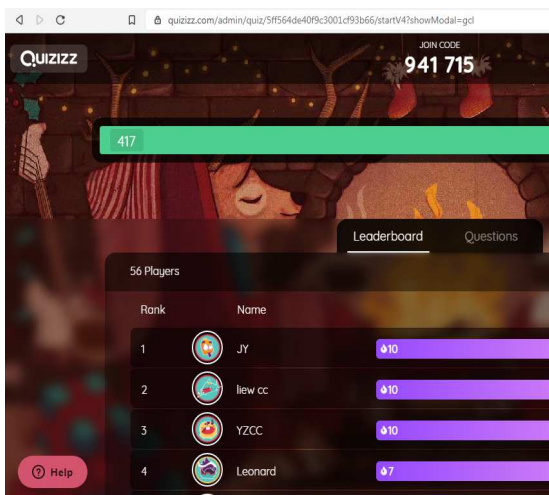


Fig. 2 Fifty-six respondents took part in this research.

2) *Survey of the problem*: This conducted study is to identify respondents' level of interest through pre-tests and post-tests. Respondents need to answer fifteen questions on e-Learning in Web Applications and Learning Management systems. These questions are used as a Pre-Test and Post-Test. The test is given after the completion of the teaching process. The pre-test is given to the respondents in advance to determine their level of memorizing the newly delivered lesson content. Then, students will participate in a quiz competition using interactive e-learning web applications such as Quizizz. In the next class, they were tested with a Post-Test where the same question was used on the previous Pre-Test. The results can be used to evaluate the effectiveness of this gamification approach on the respondents. Apart from that, questionnaires were provided to find out the perceptions and effects of this approach on the level of memory and the way of learning of the respondents.

3) *Pre-Intervention Analysis*: The results of the findings through the pre-test are depicted in Table 1. About 56% of the students get marks less than 55. This test shows that the respondents could not fully remember the facts, even though the lesson had just been learned. From a total number of 15 questions, respondents were only able to remember only half of them. This explains that students lack focus during class, and the class environment is not helping them.

TABLE I
PRE-TEST ANALYSIS

Pre-Test (%)		Pre-Test (%)	
Student29	65	Student32	55
Student30	65	Student37	55
Student50	65	Student52	55
Student1	62	Student2	52
Student3	62	Student33	52
Student20	62	Student40	52
Student21	62	Student41	52
Student43	62	Student22	50
Student4	60	Student25	50
Student7	60	Student31	50
Student16	60	Student38	50
Student27	60	Student53	50
Student35	60	Student12	47
Student44	60	Student18	47
Student48	60	Student39	47
Student5	58	Student45	47
Student6	58	Student10	45
Student13	58	Student19	45
Student14	58	Student34	45
Student15	58	Student36	45
Student17	58	Student51	45
Student26	58	Student28	40
Student47	58	Student46	40
Student56	58	Student49	40
Student8	55	Student24	38
Student9	55	Student55	38
Student11	55	Student42	32
Student23	55	Student54	32

4) *Actions Taken During Intervention*: Activities that had been implemented in getting the results of this study are:

- Conducting a test right after ending the topics e-Learning in Web Application and Learning Management System.
- Implement an interactive online quiz through Quizizz Quizzes gamification (<https://quizizz.com/>)
- Hold a Post-Test after the quiz game is over.
- Make a comparison of test results (Pre-Test and Post-Test).
- Evaluate the effectiveness of this quiz game to students through questionnaires distributed to students. The instruments used in the production of the findings of this study are pre-test and post-test questions as well as questionnaires.

5) *Implementation of Actions and Observations*: The Quizizz gamification was presented to the respondents after testing them with a Pre-Test. The description of how to play the quiz to the respondents is explained clearly by the instructor. Respondents must answer the quiz questions provided on the selected topic of e-Learning in Web Application and Learning Management systems. Part of the 10 questions from the mentioned topic is depicted in Fig. 3

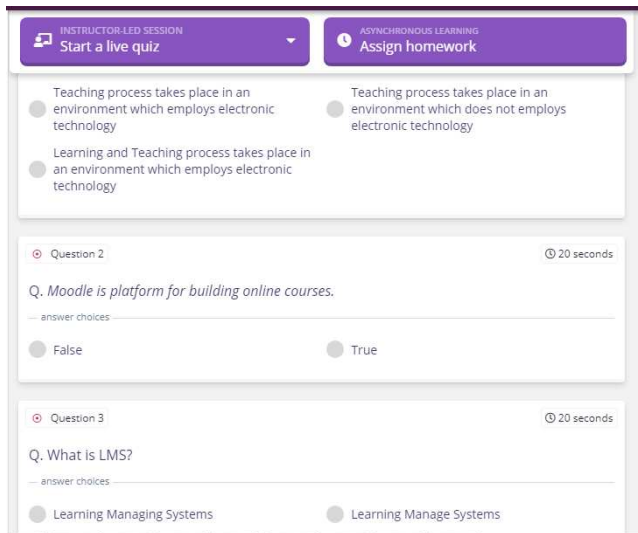


Fig. 3 Quiz questions

The attributes of the interactive e-Learning using a gamification approach with Quizizz in this study are as follows:

- Lively interactive. Students are given the opportunity to manage their own answers on their laptops, handheld devices, smartphones, or tablets. Questions are displayed on the screen while students choose the answer on the screen of their digital devices. The highest score grid is within first to fifth place. Students, who answer the fastest and most accurate of the answer choices, will be in the top ranking. Obviously, they will race to answer correctly and try to be the fastest. The participant's view is depicted in Fig. 4.
- Questions are easy to build. Quizizz also gives the freedom for instructors to set the number of questions, the number of answers, the period for answering, and the variety of forms of question presentation such as text, image, and video with various settings [26].
- Questions can be emailed to respective students' email addresses. This is also a benefit for instructors since there is no need to store information externally or in the storage of a computer. Teachers can also organize according to the topics in a particular format to make it easier to use in the future.
- Quizzes are available online. It can be accessed anywhere as long as there is internet access.
- Suitable for use in any phase of the teaching and learning process. The interactive online quiz is suitable for use during any part of the teaching and learning session at the set induction stage, reinforcement, review, discussion examination questions, or many others, according to the instructors' creativity.

- The Gamification form of Quizizz is fun. Competition elements based on the efficiency and speed of answering questions make students feel very excited and have fun during the activity.
- Rewards, appreciation, and praise for achievement to the students are displayed upon completion of a quiz. Fig. 5 shows the example of reward and recognition.

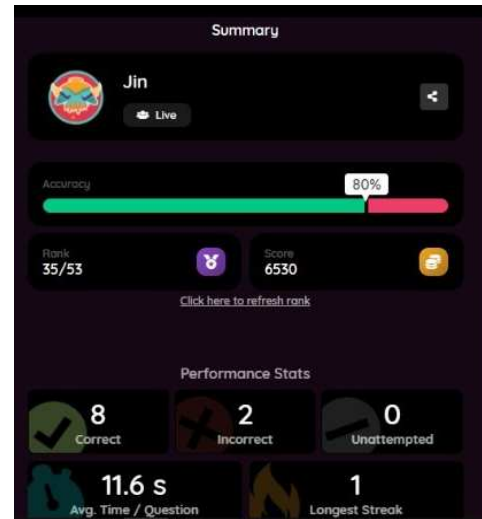


Fig. 4 Participation's view with active interactive interface.

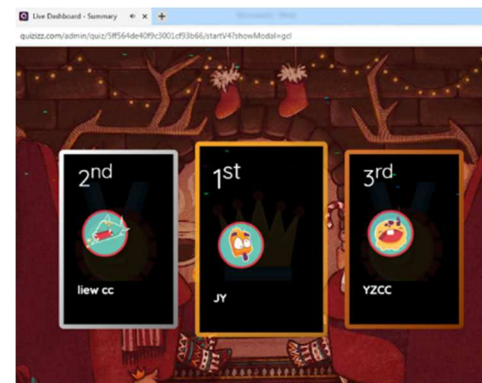


Fig. 5 A simple appreciation reward generated by Quizizz to recognize the top three achievers.

6) *Reflection*: Throughout the implementation of this quiz game, students are more excited, fun, and motivated to answer quiz questions because there is healthy competition among them. In addition, students have also used their senses in answering the quiz questions. Students can focus in class, quickly respond, and answer questions accurately.

III. RESULTS AND DISCUSSIONS

The analysis of the results and the findings of the study is presented in this section. The comparison is made between pre-tests, and Post-Test were analyzed to identify the significance of the study.

A. Test Results

The effectiveness of this quiz game can be seen from the post-test findings. If a comparison is made between pre-test and Post-Test, there has been a significant increase in terms of respondents' scores. Table 2 shows the results for pre and post test. 49 respondents (87%) have increased in terms of

their percentage of marks, 6 respondents have decreased in marks, and 1 respondent did not make any changes. In the Pre-Test result, 56% of the respondents get marks below 55% (refer to Table 1, surprisingly, in the post-test, it reduces to 14%. The percentage difference is 18% for respondents that decreased in their post-test. This is alarming, and further activities such as focus groups and refining instructional intervention procedures are essential. Table 3 displays the descriptive statistical analysis, such as mode, median and average, between pre and post Test. Finally, Fig. 6 represents the distribution of Pre and Post Test. From the analysis of the result, conclusively, assessment of tests is increased, and it is a strong indication that applying interactive gamification e-learning gained a significant advantage in the teaching and learning process

TABLE II
PRE - POST TEST RESULTS AND COMPARISON

	% Pre-Test	Post-Test	Different		% Pre-Test	Post-Test	Different
Student1	62	67	4	Student29	65	50	-15
Student2	52	65	13	Student30	65	50	-15
Student3	62	62	-1	Student31	50	63	13
Student4	60	27	-33	Student32	55	62	7
Student5	58	63	6	Student33	52	65	13
Student6	58	68	11	Student34	45	65	20
Student7	60	70	10	Student35	60	70	10
Student8	55	70	15	Student36	45	65	20
Student9	55	55	0	Student37	55	63	8
Student10	45	63	18	Student38	50	60	10
Student11	55	70	15	Student39	47	62	14
Student12	47	68	21	Student40	52	68	16
Student13	58	67	9	Student41	52	55	3
Student14	58	75	17	Student42	32	60	28
Student15	58	68	11	Student43	62	67	4
Student16	60	67	7	Student44	60	65	5
Student17	58	65	7	Student45	47	60	13
Student18	47	73	26	Student46	40	60	20
Student19	45	50	5	Student47	58	82	24
Student20	62	30	-32	Student48	60	62	2
Student21	62	68	6	Student49	40	65	25
Student22	50	68	18	Student50	65	50	-15
Student23	55	65	10	Student51	45	65	20
Student24	38	45	7	Student52	55	63	8
Student25	50	63	13	Student53	50	60	10
Student26	58	82	24	Student54	32	60	28
Student27	60	62	2	Student55	38	45	7
Student28	40	65	25	Student56	58	67	9
mean	52.94	62.32					
std dev	8.26	9.83					

TABLE III
DESCRIPTIVE STATISTICAL ANALYSIS

	Pre-Test	Post-Test
Mean	52.9	62.3
Standard Error	1.1	1.3
Median	55.0	65.0
Mode	57.5	65.0
Standard Deviation	8.3	9.8
Sample Variance	68.2	96.7
Range	32.5	55.0
Minimum mark	32.5	26.7
Maximum mark	65.0	81.7
Sum	2964.7	3490.0
Count	56.0	56.0
Confidence Level(95.0%)	2.2	2.6

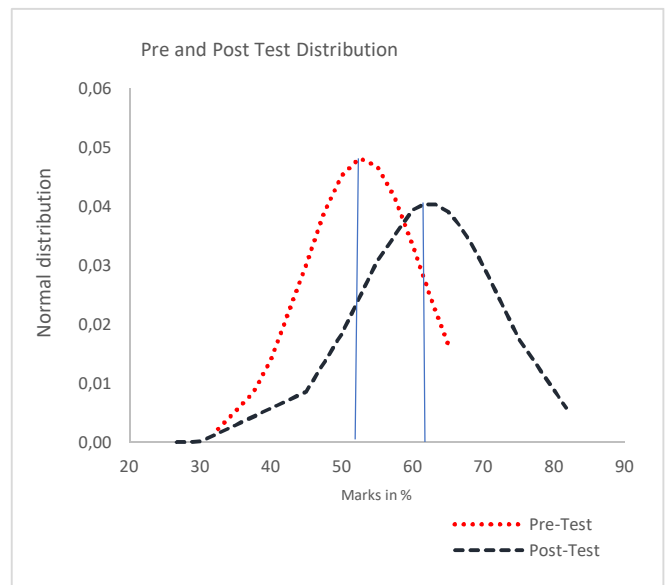


Fig. 6: Pre and post test distribution

B. Analysis of Questionnaire

Through the questionnaire completed by the respondents, as shown in Table 4, most of them alleged that online quizzes' use positively affects their teaching and learning strategies. It is especially the learning environment to be cheerful and fun. It is very gratifying that the respondents have benefited from the interactive online learning approach. The result of the questionnaire survey shows the excitement and determination of the respondents to answer the questions and see for themselves the results they obtained.

TABLE IV
RESULTS FROM THE QUESTIONNAIRES AFTER THE END OF THE QUIZZZ SESSION

Reaction	No	Percentage (%)
Interest	47	84%
Not interested	9	16%
Want to change the learning atmosphere	50	89%
Love the fun and exciting learning atmosphere like the Quizizz	52	93%
Love the learning atmosphere in the form of competitions and rewarded	45	80%

The increase in their marks is correspondingly significant compared to this approach once they participate in the learning process using the online quiz. This has proved that fun while learning is very important to remembering the facts of lesson content. In addition, healthy competition among students to win first place in this quiz competition also requires speed of action. Respondents also responded positively to continue using this online quiz in the future. Among the responses were "Yes, because it is very effective and fun." and "Yes, need to continue to use this teaching and learning strategy in the future to improve the performance of my subject further."

In general, this method gave respondents an interesting and effective way to improve their memory of the facts in this course. Although not all respondents can achieve a good level, this strategy gives them space and opportunity to study in a cheerful, fun way and create a feeling of excitement about the course content itself. Consequently, they can improve their performance in the subject and other subjects.

IV. CONCLUSION

This study aims to help students improve their knowledge capability based on active participation through a gamification approach. The assessment involved in this study is through pre-test and post-test, where instructional intervention by adapting interactive gamification e-learning. Fifty-six respondents participate in this study. The four objectives of this action research are achieved based on the reflection of the research output. 87% of the respondents have increased their percentage of marks. In the pre-test result, 56% of the respondents get marks below 55%. Remarkably in post-test, it reduces to 14%. It can be concluded that this strategy helped to provide respondents with an interesting and successful way to enhance their memory of the facts in this course. Although not all respondents can achieve a high standard, this approach gives them ample space and opportunity to learn in a fun, cheerful mode and build a sense of enthusiasm about the content of the course itself. Consequently, in the subject and other subjects as well, they may enhance their results. The future study enhancement can be done by adopting other gamification applications, a large target group size, and adding computer science or information technology courses.

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