A Gamification Approach for Making Online Education as Effective as In-Person Education in Learning Programming Concepts

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Rawan M. Abu-Hammad(✉), Thair M. Hamtini
University of Jordan, Amman, Jordan
rawanabuhammad1991@gmail.com

Abstract—Gamification is a contemporary concept. It is defined as using game elements such as points and badges in a nongaming environment. This paper takes a profound look at gamification methods in an academic study and comes out with a gamification approach in an attempt to make education more effective. To test the approach described in this research, an experiment was conducted by dividing 46 students in a C++ programming class at a high school into two groups; the first is In-person learning group, in which students learn through the traditional classroom method. The second group is Gamification-based group, for which the researcher designed and built a specific gamification platform by following the guidelines presented in this research study. The results analysis proved that the level of motivation and engagement in the lesson was sufficient. Furthermore, the result of the relationship analysis between variables points and the leaderboard has a strong correlation of $r = –0.897$ and $p < 0.01$. Another relationship that was analyzed is Points and Concepts attempts. This relationship positively affected student motivation and quality of learning with a moderate correlation of $r = 0.450$ and $p < 0.05$. Regarding the questionnaire analysis results, students preferred the Leaderboard by 60.9%, Points by 21.7%, Levels by 13%, and Badges by 4.3%. As for the interview conducted with teachers specialized in teaching C++, they encouraged the exploitation of the gamification approach in learning programming language concepts, and from their point of view that this approach helps to increase the motivation and engagement of students in the lesson. Further research is needed to improve this approach to learning by designing rules and guidelines to bridge the gap with other gamification approaches.

Keywords—e-learning, gamification, programming languages, C++

1 Introduction

Researchers and lecturers have exploited the gamification approach used in education. The gamification approach as it is now used emerged in 2003. in this context, the English developer Pell built his consulting firm based on gamification to promote consumer goods, bringing fun elements to devices. The idea did not work, and the company closed its doors, but it was said that the game's concepts could be used on

consumer products. In 2007 the first commercial gamification platform was launched that uses game mechanics to score goals related to the company's business vision. between 2009 and 2010, the term gamification became famous and more popular as the Quest to Learn Gamification School began receiving sixth graders in a game-based learning environment [1]. Researchers defined *gamification* as the process by which game elements such as points, badges, and levels are used, in addition to mechanics, the rules of the game, and their application to a non-game environment to increase user engagement and motivation [2, 3]. Gamification has recently been included in teaching school and university students some subjects. For example, learning some programming languages through gamification to increases students' engagement and motivation to learn [4]. This paper searches for the possibility of finding an approach through which gamification can be used to teach students some programming concepts such as C++. Finding the effectiveness of utilizing gamification in learning on the students' results, motivation, and engagement to learn. In high schools and universities, students face difficulties understanding computing languages. They encounter some unfamiliar terms that need to be depicted through an explanation to clarify how the process occurs in the computer memory [5]. The subject of programming language in school and university classes is essential in computer science. Nevertheless, significant numbers of students face challenges in learning these programming languages. Some students drop or withdraw from these subjects because they cannot understand and pass [6]. Students face some challenges in learning programming languages as follow: – Firstly, low motivation. – Secondly, lack of engagement [7].

Therefore, to enhance the teaching methodologies of programming in schools, this study proposed using gamification as an approach to increase the students' engagement and motivation by using the competition through the leaderboards, where competition is one of the types of game elements under the name of dynamics [8]. This approach can meet the challenges that take place through in-person (face-to-face) learning to increase motivation, improve the level of engagement, and as a result, reach the level of success and desired achievement [6, 9].This research is significant because It provides all adults asynchronous learning and helps in making online education more accessible and equitable and focuses on enhancing adult online learning skills by introducing gamification as a tool to deliver programming classes to students in Jordanian schools. On the other hand, from a social perspective, it may help bridge the gap between new technologies and the current educational system.

The aim of this research is to study the effect of the gamification approach on increasing the motivation and engagement of students to learn an online programming language in Jordanian schools. Also, to highlight the importance of using gamification in developing students' programming languages skills and simplifying the process of remote teaching during crises. The structure of the research is divided into sections. The first section starts with the introduction that is already introduced. The second section presents previous studies that resorted to e-learning using gamification. It reviews the gamification concept and explains how it is used its elements. Although how gamification affects student motivation and class engagement. Section three presents the research methodology, tools, and the experiment followed in this research. The fourth section introduces the guiding rules and the proposed approach for developing and designing gamification in teaching some programming languages. section five shows how to develop and implement the gamification platform, the characteristics of the

server used, and the implementation of game elements. The sixth and seventh sections present an analysis of the study tools with their results. Furthermore, it discusses these results, a summary of the results, the research conclusion that will be presented, and future work for this research.

2 Literature review

Gamification is one of the effective methods used in teaching and learning activities in the current time. Noticing the increasing use of gamification approach, it is still in the first stage [10, 11]. Literature defines *Gamification* as an interactive process in which the game mechanics and elements are applied in a non-game environment [12].

Çubukçu, 2017 [13] developed a platform utilizing the gamification approach. This platform is called GeNIE, and where game elements were used, such as points, leaderboard, badges, and achievements. This platform was used to teach an introduction to Java to University College Dublin students and had different stages. In the first stage, a java course was added to the platform. In the second stage, the game element options were activated. The platform led the teacher to activate or cancel some of the game elements. After that, upon completing the course preparation and being ready to be handed out to students, the student can then enter the platform and start the game. The student moves from one level to another, obtains badges, and collects some points required in the game. The last screen in the game displays what has been accomplished. To evaluate the utilization of the gamification approach in teaching Java, a questionnaire was created and distributed to the students after completing the game; to know their opinion about what was presented through a set of questions. Statistical analysis was conducted on the questionnaire results by calculating the arithmetic mean and standard deviation of the nine questions, the results of which ranged in the arithmetic mean between 3.52–4.65. The first question took the lowest rank of 3.52, "Do you want other users to be able to see your progress?" This result indicates that the students prefer to keep their results private. The question that took the highest rank of 4.65 is, "Would you put in more effort and time to see your name on the Leaderboards?" This result means that the next time the students will strive to achieve better results by putting in more effort to get satisfactory results. The standard deviation was between 0.58 and 1.12. The last question discussed the importance of continuing to use the system for students. The arithmetic mean of each answer to this question was calculated. The answer "I want to see my name on the leaderboard" got the highest rank with a score of 4.00. The answer "I want badges" got the lowest rank with a score of 3.62. These numbers may indicate that the students had difficulty obtaining the game element, which is the badges. The researchers did not analyze the game elements, but it was included in future research work. Furthermore, adding the reporting section to the system allows the instructors to track students' actions and progress through the system.

Another researcher finds that students still have problems understanding, learning, and teaching programming languages among students at the College of Information Technology of Cagayan State University. The researchers thought of designing an architecture to teach the C# language by using a gamification approach. The teacher could add the material required for the course and add some homework and short exams. In addition, all with the presence of the game elements where there are challenges,

moving from one stage to a higher stage, collecting the required points and achieving the required badges. A questionnaire was built and presented to the students before designing and developing the game to find out the correct scientific level of the students in programming through five options: Very High Proficiency, High Proficiency, Moderate Proficiency, Low Proficiency, Proficiency very low. The questionnaire responses were classified using the KMeans and X-mean algorithms. The clustering resulted in three groups, cluster 0, cluster 1, and cluster 3. For example, cluster 0 showed that 60% of students had the best proficiency in general programming. Furthermore, 40% of students had poor proficiency in program variables, program data types, basic program structure, writing program statement expression, knowledge in decision control structure, loop control structure, and basic flowcharting symbols. The researchers concluded that a group-specific learning strategy should be used to match the students' level of programming skills [14].

Legaki, 2020 [15] experimented to investigate the effect of learning statistical prediction through challenge-based gamification on the students. He still sees a blind spot in the gamification field, which is the best gamification approach to be utilized. Three hundred sixty-five university students from two academic majors participated in this experiment, 85 from Business Administration and 279 from electrical and computing engineering. Researchers have developed a challenge-based gamification approach called *Horses for Courses*. This course includes the essential elements of the game, namely points, levels, challenges, and the leaderboard. The methodology of this paper explained that the students were divided into four groups: the first group is the traditional group, where students traditionally study statistics forecasting. The second group is the reading group, where students of this group read a research paper. The third group is the playgroup, where students learn through a website designed to teach students through playing, which contains the elements of the game. The fourth group is the reading and playing group, where the student of this group reads a research paper and then learns through the site. The time for each group to learn is determined in an equal manner. Regarding the experiment, students in all groups are subjected to a test containing earlier explained questions during the lesson to which the student belongs. The students' results in this test determine the extent of the impact of the gamification approach on the student's performance. After experimenting, the researcher analyzed the students' results by extracting the mean and standard deviation and using the Anova nonparametric Kruskal's test. The researcher concluded that the groups that used the gamification approach in learning had better results for their students' performance than the other groups, specifically the reading and playing groups.

[16] presented a proposed approach for the gamification method, which included four steps. The first is to define the content presented in the gamification approach and for which the teacher is responsible. This step contains sub-steps which are the analysis of content, the mapping of activities, mapping of social network features and the representation. The second step was defining the game elements to be used in addition to determining the gamified tasks and evaluation. The third step was the implementation and dissemination phase, where students implemented the duties required in the class. As for the last step, the evaluation stage was where students filled out a questionnaire to determine the extent to which students accepted the gamified tasks. The researcher did a case study for 40 students to learn programing concepts. As a result, the gamified strategies that were created achieved positive acceptance among the students and instructors.

On the other hand, the research presented by de la Peña [17] suggested guidelines for applying the gamification approach. They were as follows: choosing the topics to be taught through gamification, set up the variables related to gamification, such as which laboratories are used and whether it will be individual or in the form of a group, then choosing the appropriate gamification technique, then the process of the development then determines the date on which the topics will be available to students, the results and validation, and finally the lessons learned from the utilized approach, which is gamification. The researcher did a case study for 51 students to learning four subjects on Moodle classroom. As a result, for the gamified approach that were proposed achieved a high interaction between the students in the class, decreasing in dropout rate for the subjects, increasing in number of passes.

In Research [18], the researcher follows steps to implement gamification in education. First, he begins by defining the game elements from mechanics, dynamics, and aesthetics. Second, describe the architecture of dynamic gamification elements by showing the architecture model for learning applications. Third, eliciting the architecture details for you through dividing this step into three stages. The first stage divides the educational content into subjects, chapters, lectures, and topics. The second stage is data collection by holding short exams, the points system, the leaderboard, and knowing who the top 5 are. The third stage is the user interface, where the designer planned for each screen that will appear to the learner, as each screen will be different from the other. Fourthly, evaluation. In this step, the environment in which the experiment will the students conducted is determined, who the learners are and their type, and the researcher's tools for the analysis process. Fifthly and finally, the results and recommendations of the curriculum developed by the researcher to use gamification in learning.

In comparing the gamification approach and guiding rules proposed in this paper with the approach followed by other researchers, this research focused first on understanding the learners and their nature instead of knowing the game elements that are required for gamifications., For examples [18] put the step of knowing the learners in the last stage of his gamification approach. Furthermore, the goal of utilizing gamification does not exist in the research approach presented by the researcher. In contrast, the goal of utilizing the gamification approach was the second step of the guidelines proposed in the paper. In addition, the development of a gamification approach proposed in this paper should also help in bridging other gaps in the approaches that were presented in previous studies such as the type of programming language want to learn, which may positively affect the educational process of students. This section explained previous studies based on specific methodologies that utilized different gamification approach, the following section will present the research methodology utilized in this paper.

3 Research methodology

The utilized methodology adopts the quantitative and qualitative approach found in the tools used in the study, which are the interview, pre-test, post-test, and questionnaire. Figure 1 illustrates the current research methodology workflow that will be utilized to accomplish the research objectives.

3.1 Conducting qualitative research

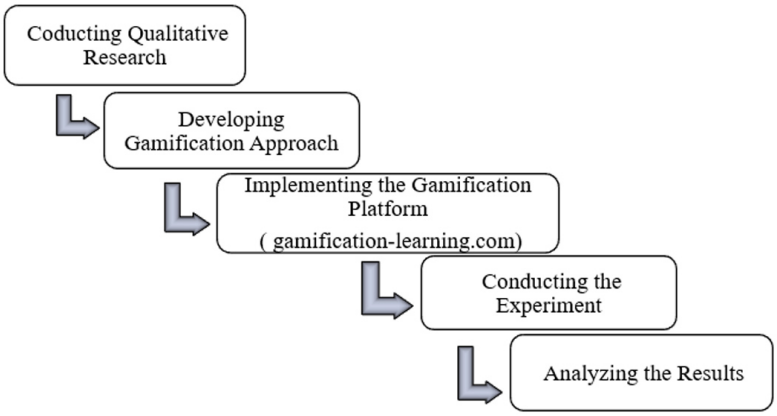

Fig. 1. Research methodology workflow

The first way of data collection to build a gamification methodology is to search for gamification approaches in previous studies. In this way, we can bridge the previous gamification approaches to build our gamification approach. In order to accomplish the gamification approach building for this paper, the researcher used the second way of data collection by conducting an interview with three teachers who learn C++ language to 11th grade students to know their opinion about the use of the gamification approach in learning some concepts of C++ and its applicability to students in Jordanian schools. The interview consisted of 13 questions built on google forms. It presented to academicians in the field who validated and confirmed it serves the purpose for which it was designed which made this tool reliable to be utilized.

3.2 Developing gamification approach

The approaches of gamification that the researchers exploited in learning are many. In this context, we surveyed previous studies that used gamification in learning programming languages. However, we investigated their approaches to build a gamification approach for this paper that can be applied to the students. The developed gamification approach covers issues and aspects not included by previous studies such as student types and the reason behind utilizing gamification approach. The gamification approach will consist of five steps. They are guidelines for exploiting gamification. This approach can be utilized by academics who want to use gamification to learn their students programming languages.

3.3 Implementing the gamification platform (gamofication-learning.com)

It is an educational platform created through a web-based to test the effectiveness of utilizing gamification in learning some concepts of the C++ language to students. An academic account is built on the platform for each student who wants to learn

through gamification. Game elements such as points, levels, badges, and leaderboards have been activated. The platform introduces two concepts that the teacher explained using gamification, these concepts from C++ language, namely, data types and selection If statement. These concepts had questions in the form of games that the student could interact with. After that, students are given a post-test on the platform to reveal how learning through gamification affects their results.

3.4 Conducting the experiment

Figure 2 explains how the experiment carried out in this paper works and the stages involved.

Fig. 2. The experiment stages

Setting. The study will be conducted in a Jordanian school in Amman for eleventh-grade students, and the school will have an appropriate technical infrastructure to implement this study.

Participants. The participants in testing the hypothesis of the paper, which studies the effectiveness of gamification in education, are 46 11th grade female students. Where the C++ language is one of the subjects, they have in the academic syllabus of computer subjects. group of the students will learn some C++ concepts through the traditional in-person method where the teacher explains the ideas in the class session. The second group of the students learns the same concepts that the first group students accomplished, but through a gamification approach. These students are unfamiliar with programing languages domain.

Group 1 and Group 2. In this stage, the 46 female students are divided randomly into two equal groups containing 23 students. The first group is the in-person learning group, we ensured that students have not learned C++ concepts before. The experiment

is carried out with students in the first semester before they started the C++ unit in the computer curriculum. The students learn the If statement and Datatypes through the traditional face-to-face method by the teacher from direct explanation and solving exercises and questions. The second group is the gamification-learning group, where students learn the If statement and Datatypes through their presence on the gamification-learning.com educational platform. Each student has an account that she can access on the platform by entering her username and password. Students of the second group learn through the gamification approach through the availability of game elements such as points, levels, badges, and a leaderboard.

Pre-test. The stage that follows distributing the students into two groups is conducting the pre-test. These two groups performed this test, each containing 23 female students from 11th grade of secondary school, with total 46 female students. The pre-test is one of the research tools consisting of 10 questions created on google forms. This test assesses the strength of students' skills in programming languages and reveals whether they have any programming knowledge. These test results can compare with the post-test result and discover the effectiveness of the gamification approach. We introduced this tool to three C++ teachers, who validated it by reviewing the questions provided and confirmed that the test serves the purpose for which it was designed. This review made the tool reliable to be presented to students.

Learning C++ programming language concepts. At this stage, the concepts of the C++ programming language are learned in two ways, the first through the traditional method, and the second through gamification.

Learning through an in-person way. In this way, the teacher utilizes the in-person learning method to teach concepts of C++. In the experiment, students in the first group studied two concepts in C++, namely the If statement and Datatypes, through two study sessions, each session lasting 50 minutes. In which the teacher explained the concepts with examples and exercises. The student can ask the teacher any question during the class to enhance her understanding.

Learning through gamification approach. Learning through gamification is a recent trend in education. In this paper, the experiment examined the effectiveness of this approach in learning. At the beginning of the experiment, a pilot study was carried out with three female students by entering the platform, trying the concepts, and providing any feedback to be taken into consideration. Twenty-three students from the 11th grade of high school learn the IF statement and data types through a gamification approach. The teacher provided two concepts explaining them with questions in the form of games that each student could perform an unlimited number of times at home. Upon completing each concept, the student gets a certain number of points plus badges and passes certain levels. After students complete each level, they can see their rank among their peers through the leaderboard.

Post-test. The post-test consists of 10 questions. It is conducted by the in-person and gamification learning groups. For the first group of in-person learning, the post-test was created on google forms, and students took this test through a class session in the school's computer lab. As for the second group, learning by gamification, after the students finished the concepts on the platform, they conducted the post-test created on the "Gamification-learning.com" where all the students entered at a specific time to

solve the test from their homes. Test time is extended to all students for an equal period. The post-test is one of the study tools that help discover the impact of gamification and in-person learning method on the student's results, understanding, and comprehension. This tool was introduced to three C++ teachers, who validated it by reviewing the questions provided and giving feedback. This review made the tool reliable to be presented to students and confirmed that the test covered the concepts presented to students.

Questionnaire. The questionnaire is the last study tool that the experiment used. It is intended for students of the second group, learning by gamification. The students submitted the questionnaire after they completed the post-test. This questionnaire aims to discover the opinion of the students and know their points of view on the game elements presented on the educational platform, such as points, badges, levels, and the leaderboard. Furthermore, it aims to find out the best and most enjoyable game element for students. The questionnaire had 10 questions. Three teachers who expert in learning C++ reviewed the questionnaire, where they confirmed that it serves the purpose for which it was designed, and it is valid and reliable to use.

3.5 Analyzing the results

This Experiment based on the exploitation of quantitative approach due to utilize the following study tools: the pre and post-test and the questionnaire. The statistical analysis will be done using the IBM SPSS software. The analysis will be as follows: First, an analysis will be conducted for the pre-test and the post-test for the two groups and get findings. Second, we will analyze the answers of the questionnaire and their results will be discussed. Through the analysis of the tests, we will reveal the impact of learning through the gamification approach and learning through the traditional in-person (face-to-face) method on students' results and their understanding and comprehension of C++ concepts. Third, the motivation and engagement of the students who learned through gamification will be analyzed by investigating the relationship between the points they scored and number of concept attempts. Also, studying the relationship between the number of times students click on the platform and the number of times they enter it. Finally, analyzing the relationship between the number of points the student gets, and the student's rank on the leaderboard.

4 Guidelines for designing and developing gamification approach

The gamification approach can be created that accommodates students' requirements in the educational content that the student needs in creative and practical way, which helps students accept it faster and increase their motivation and engagement to continue learning through it [16]. An interview was conducted with teachers teaching the C++ programming language. Their answers to the interview questions had a role in knowing how to build the gamification approach that will be followed in this paper.

4.1 Qualitative data gathering

The interview is the first study tool that has been built. It aims to ask teachers who teach C++, specifically the 11th grad students on whom the research was conducted, and to know teachers' opinions about utilizing the gamification approach in learning a programming language. Furthermore, consider their views when building the gamification approach. The interview consisted of 13 questions verified by two academics from Al-Balqa Applied University and King Abdelaziz University. The number of interviewees was three teachers whose experience ranged in teaching, specifically in C++, between 16, 17, and 20 years.

All participating teachers confirm that there is a difficulty faced students when teaching C++. To discuss the teachers' opinions resulting from the interview, the teachers emphasized the possibility of using gamification to learn some C++ concepts. Teachers' opinions helped develop the gamification approach, where teachers emphasized the attention to students' type and the language they need, in addition to choosing the appropriate playing element that can increase their motivation and engagement in the lesson. In their opinion, this could increase their motivation and engagement to learning C++ language, and this opinion comes from their significant experience in teaching C++ to secondary school students. Teachers' opinions varied about the best game element used in the gamification approach. Some of them realized that points could achieve the best motivation for students. As for the badges, three teachers found them to be the most influential in the students positively. Finally, another teacher considered that the levels could make the student more motivated and connected to the electronic lesson. On the other hand, the teachers did not confirm the possibility of a positive impact of the gamification approach on students' results because the student must develop the practice side. Although, trained in writing programming statements to relieve their weakness in programming thinking. In this context, the experienced teacher with parents believes that they will allow their children to deal with electronic lessons through the gamification approach for a specific time per day. These students are from the technology generation who have electronic devices such as tablets and smartphones with them with ease. Finally, the teachers emphasized that using the gamification approach would play a good role side by side with the in-person lectures and practice in the computer lab. It was moreover motivating the students and helping the teacher learn the students some concepts in the C++ language. Furthermore, consider the differences between the students and not make it a substitute for the traditional way face-to-face and find a solution for the absence of the feedback.

4.2 The developed gamification approach

We developed an approach for this research and set special guiding rules for gamification. The following Figure 3 is illustrating the guidelines that were used to build the gamification approach in this paper.

Fig. 3. Guidelines for designing and developing gamification

1. Know the learner through Deciding the students' type that needs the learning through the gamification approach. The gamification can be used for school students, whether at the primary, middle, or secondary level. Moreover, students at the university can utilize gamification regardless of their stages. The thesis's experiment adopted the school's adults.
2. Determine a reason for using the gamification approach in education. The following question can summarize the causality: What is the need to utilize the gamification approach in education, and what is its purpose? When there is a clear answer, we can start the gamification approach and move on to the other steps. This thesis used a gamification approach in learning some concepts of the C++ language when the students found it challenging to understand. Furthermore, they often did not reach the required academic achievement level. The literature says that using the gamification approach with some game elements may increase the students' motivation and engagement to the lesson, thus their ability to obtain the required academic achievement Larger. This study will investigate the mentioned say by experimenting with students.

3. Choose the programming language to be taught to students, such as java, python, C#, and C++. The research methodology used in this thesis found that students prefer learning C++ language using a gamification approach based on the study of students' need for the type of language they should comprehend. In the context, the teacher must determine the educational material to explain and present through the gamification approach. After that, analyze the content and clarify the most critical concepts and topics the student needs to learn. For example, the teacher, after determining the student's need to learn a programming language and its concepts through the gamification approach, then analyze content by highlighting the essential concepts in it for students to learn, such as the C++ programming language and the data type concept.
4. The game designer should choose the appropriate game elements in the gamification approach to increase the students' motivation to learn and improve their engagement with the lesson, such as points, levels, challenges, and badges.
5. Determining the mechanism for implementing the gamification approach identified by the teacher, as there are multiple ways for this, such as developing an educational platform that carries the required game elements as a web-based or a system that the student can download to the computer.

5 Implementation of the platform "gamification-learning.com"

An educational platform was developed so that students of the gamification group could learn C++ concepts through game elements such as points, badges, levels, and a leaderboard. The education platform was called https://gamification-learning.com/, Figure 4 shows the gamification platform model.

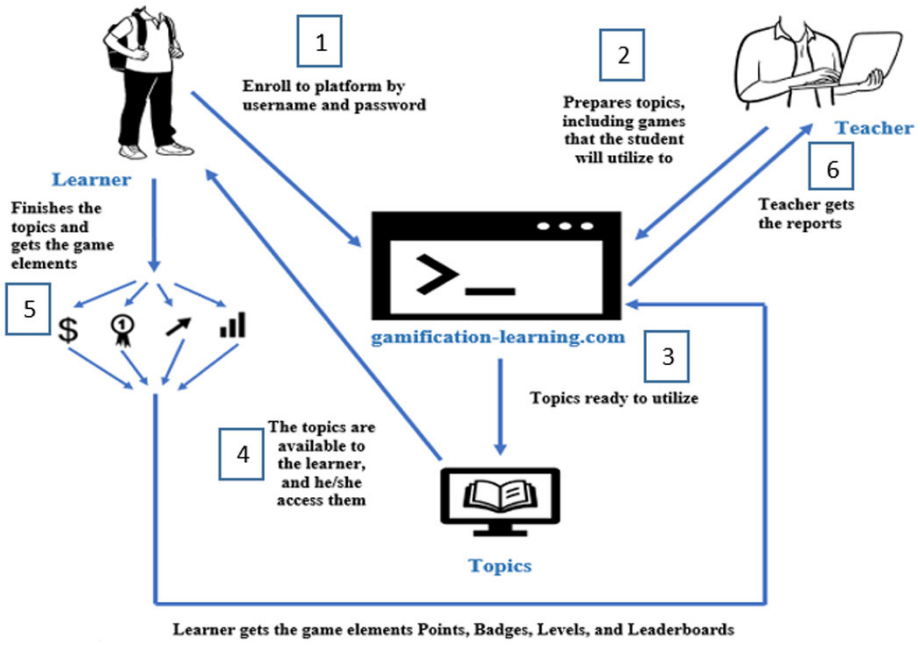

Fig. 4. The gamification platform model

In the details, an account was created attached with a username and password for each student in the gamification group; through this account, it is possible to enter the platform and learn quickly.

5.1 Game elements

Points. Points are used for two primary goals in games: discovery of progress and performance. Points obtained and indicating progress are generally called experience points. In games, experience points are accepted in many ways, including completing missions or defeating opponents. In education, there are no opponents. So, the accumulation of experience points is done by completing various tasks. Progress score often means the extent to which the user is in a game system. A more significant progress score can be interpreted as a more profound knowledge of the system in question and the user's progress through the content. The second objective of using points is the performance indicator. There is a course of action for the student; when it is implemented, the earned points are converted into actual grades. The game designer or instructor can name performance points according to the context in which they are used. In a game, performance points can be called metals, coins, points, or even lightning strikes. In coursework, a name is chosen appropriate for the content and is acceptable to students. Usually, the total score indicates the student's performance and quality within the system [13, 19]. On the platform, when students finish each game, they collect specific points to end up with their sum of completing all the games by collecting 9000 points.

Badges. Badges have a long history in many fields outside of gamification, as researchers dated their appearance to 1911. It can be defined as a tool used as an indicator to validate achievement, skill, quality, or any interest that students can gain in different learning environments. In the context of education, badges are chosen in a wanted setting to accommodate diverse learners, given their levels and motivational abilities. As students' progress through the levels, the student can collect multiple achievement badges. These badges are an online record of the learner's learning achievements. By obtaining the badges, the student feels internal satisfaction with the achievements he/she was able to accomplish and achieve, which motivates him/her to continue doing so. The badges are also a record of the student's past and current successes and help enhance the student's self-efficacy and self-efficacy qualities [13, 19, 20]. The gamification platform for this thesis presented five badges, their names as follows: Explorer Student, Persevering Student, Confrontation Student, Smart Student, and Hardworking Student. Details of how to get them will be explained in the Gamification Rules section.

Levels. In games, levels are always defined by the tasks to be accomplished. Once the tasks are completed, the learner automatically moves to another level with more incredible difficulty and a different user interface of colors and page layout. When a higher level is reached, learners can sometimes obtain specific points or badges on some learning platforms. Getting the required levels indicates an achievement in which the learners feel satisfied, motivating them to continue at the same level and do their best [19]. The gamification platform for this thesis designed eight levels, their names as follows: 1- Beginner student, 2- Competent student, 3- Proficient student,

4- Excellent student, 5- Super intelligent student, 6- Diligent student, 7- Ambitious student, 8- Challenge student. Details of how the students move from one level to another will be explained in the Gamification Rules section.

Leaderboards. Researchers define leaderboards as a visual display that rates players according to their achievement and points accumulation. Due to the nature of the leaderboard design, researchers emphasize students' continuous performance, compare their performance to each other, and report on their status. The leaderboard can be categorized into absolute/infinite or relative/no damper. The first type, Absolute Infinite, displays all users and their scores, making players experience more significant accomplishments than those at the bottom of the board. Students only see their rank in the second type compared to the users ranked below and above them [13, 21, 22].

5.2 Gamification rules

The game elements utilized on this platform are points, badges, levels, and a leaderboard. There are rules governing the mechanism for obtaining these elements during learning. In topic one, lesson1, the students stand in the first level Beginner Student. Once the students enter the topic, they get 500 points. This lesson contains a video and two games. The students will receive 1000 points and the Student Explorer badge upon completing the video. The total points become 1500. In this case, the student finishes the first level and moves to the second level Competent Student, the beginning of the drop and drag game, from which the student can get 1000 points. The sum of the points becomes 2500, and the second level ends. In the buzzle game, the third level Proficient Student begins, where the student can collect 1000 points, bringing the total points to 3500. After finishing the previous two games, the students receive the badge of the persevering student. As for topic 1, lesson 2, the fourth level Excellent Student begins with the Gameshow Quiz, where students collect 1500 points for a total of 5000 points, and at that time, the student gets the confrontation student badge. After that, topic 2 lesson 3 begins with the fifth level Super Intelligent Student. Once the students enter this lesson, they get 500 points. It contains an IF statement video the cards game. After the students finish the IF statement video, they collect 1000 points, for a total of 6500 points. Then they move to the sixth level Diligent Student with the cards game, where the students can collect 1000 points for a total of 7500, and then the students will receive the Smart Student badge. When starting with topic 2 lesson 4 with the missing words game, the seventh level Ambitious Student begins, collecting 1500 points, bringing the total points to 9000 points, and obtaining the Hardworking Student badge. These achievements enable them to move to the eighth level Challenge Student. The students can perform the post-test through this level, which measures the extent of understanding and impact of the game elements on their learning of C++ language concepts. After the students finish all levels, their points collection results appear on the leaderboard with the rank they obtained among their colleagues. The student with the highest number of points gets the first rank, and her name is the first on the leaderboard. The names of the levels and the badges utilized in the gamification process were approved after consultation and approval of teachers specialized in teaching C++. Teachers believe that students prefer to see motivational names for levels and badges rather than numbers, which significantly encourages students during the learning process.

6 Results and analysis

The data analysis will be clarified and interpreted in detail by utilizing the frequencies, descriptive analysis, Independent-Samples T-Test, Paired-Samples T-Test, and Correlation Coefficients to find the relationships between the variables. Statistical Package for Social Science IBM SPSS Statistics 26 is a software used to analyze this data.

6.1 Pre-test analysis

Pre-test analysis results. Students in the gamification group and students in the face-to-face group performed the pre-test, and Independent T-Test analyzed their results. Table 1 shows the results of the pre-test analysis for the two groups. SPSS expressed the t-test results according to the null (H0) and alternative (H1) hypotheses as follow: H0: there are no differences in the pre-test means. H1: there is a significant difference between the pre-test means. The gamification group arithmetic mean was 40 with a standard deviation of 19.3, which is less than the mean of the in-person (face-to-face) group of 43 with a standard deviation of 24.01. The T-test result came –0.474 with a Sig (2-tailed) value of 0.638 greater than the significance level of 0.05; accordingly, the T-test revealed no significant differences at the 0.05 level between the means of the two groups the following figure illustrates these results.

Table 1. The t-test result for the difference between the arithmetic mean of gamification and in-person (face-to-face) groups in the pre-test

Group Name	Students Number	Mean	SD	T Value	Sig (2-Tailed)	Statistical Significance
Gamification	23	40	19.3	–.474	.638	It is not significant and accept the null hypothesis
face-to-face	23	43	24.01			

6.2 Post-test analysis

Post-test analysis results. Students in the gamification group and students in the face-Students in the gamification and the face-to-face group performed the post-test. SPSS software analyzed their results by utilizing the Independent T-Test. Table 2 shows the results of the post-test analysis for the two groups. The results of the t-test independent on the existence of the null and alternative hypotheses. In this context, Null hypotheses (H0) mean there are no differences in the post-test means. The alternative hypothesis (H1) means there is a difference between students' average scores for the post-test. Table 2 presents the mean of the gamification group 91.8 with a standard deviation of 15.6. It is higher than the mean of the face-to-face group of 66.3, with a standard deviation of 14.3. however, the T-test result came 11 with a Sig (2-tailed) value of 0.000. it is smaller than the significance level of 0.05; accordingly, the T-test revealed significant differences at the 0.05 level between the means of the two groups.

Table 2. The t-test result for the difference between the arithmetic mean of gamification and in-person (face-to-face) groups in the post-test

Group Name	Students Number	Mean	SD	T Value	Sig (2-Tailed)	Statistical Significance
Gamification	22	91.8	15.6	11	0.000*	Yes, it is significant, reject the null hypothesis and accept the alternative one.
face-to-face	23	66.3	14.3			

Note: *Correlation is significant at the 0.05 level.

6.3 In-person (face-to-face) group analysis result

This face-to-face learning group consists of 23 students who have taken a pre-test that generally measures their skills and knowledge of programming languages. Then the teacher explained some C++ concepts traditionally. From Concepts, they learned about IF statements and data types. Then, the students took a post-test to evaluate their understanding of the explained concepts from C++. Student achievement outcomes were analyzed to see the effect of the traditional (face-to-face) learning method on student outcomes in this group. SPSS software compared the students' pre-test results with their post-test results through a non-parametric alternative to the paired-sample T-test; because the normal distribution of students' results did not exist. The null and alternative hypotheses were the basis for the non-parametric test. The null hypothesis came assuming no difference between the post-test and pre-test arithmetic averages for students. On the contrary, the alternative hypothesis confirms a significant difference between students' pre-and post-test arithmetic averages. Table 3 shows the non-parametric test on pre and post-test for in-person (face-to-face) group. The analysis of students' result showed that the pre-test's mean is 43, and the arithmetic mean of the post-test is 66.3. The analysis shows that four students had a score in the pre-test higher than their scores in the post-test. Also, 19 students whose scores in the post-test were higher than their scores in the pre-test. The statistical significance was .000, lower than .05, so the null hypothesis is rejected. As a result, there is a significant difference between the arithmetic means of the two tests.

Table 3. Non-parametric test on pre and post-test for in-person group

Test Type	Students Number	Mean	SD	Sig.	Decision
Pre-test	23	43	24	0.000*	Reject the null hypothesis and accept the alternative one.
Post-test	23	66.3	19.8		

Note: *Correlation is significant at the 0.05 level.

6.4 Gamification group analysis result

The Gamification learning group consists of 23 students who have taken a pre-test that generally measures their skills and knowledge of programming languages. Then they attended four lessons on (https://gamification-learning.com) that explained some C++ concepts by utilizing game elements: points, badges, levels, and leaderboards.

From Concepts, they learned about IF statements and data types. Then, 22 students took a post-test to evaluate their understanding of the explained concepts from C++. Student achievement outcomes were analyzed to see the effect of the gamification learning approach on student outcomes in this group. SPSS software compared the students' pre-test results with their post-test results through a non-parametric alternative to the paired-sample T-test because the normal distribution of students' results did not exist. The null and alternative hypotheses were the basis for the non-parametric test. The null hypothesis came assuming no difference between the post-test and pre-test arithmetic averages for students. Conversely, the alternative hypothesis confirms a significant difference between students' pre-and post-test arithmetic averages. The analysis of students' result showed that the pre-test's mean is 40, and the arithmetic mean of the post-test is 91.8. The results show that zero of students had a score in the pre-test higher than their scores in the pre-test. Also, 22 students had scores in the post-test higher than their scores in the pre-test. In addition, zero students whose scores in the pre-test were equal to their scores in the post-test. The statistical significance was 0.000, less than 0.05, so the null hypothesis is rejected. As a result, there is a difference between the arithmetic averages of the two tests. Table 4 shows the non-parametric test on pre and post-test for gamification group.

Table 4. Non-parametric test on pre and post-test for gamification group

Test Type	Number of Students	Mean	SD	Sig.	Decision
Pre-test	23	40	19.76	0.000*	Reject the null hypothesis and accept the alternative one.
Post-test	22	91.8	15.6255		

Note: *Correlation is significant at the 0.05 level.

As a discussion for the results, the students' results in pre-test found that the programming level of the two groups before learning any concept of C++ is equivalent. They do not have a background in programming languages in general. In the post-test, the analysis's results showed that the results obtained from the gamification group are more significant than the results of the face-to-face learning group. The results indicate those game elements such as the leaderboard, points, badges, and levels can increase the student's motivation to learn and increase the class's engagement, thus increasing achievement.

6.5 Relationship between game elements and motivation and engagement

The students learn some C++ concepts on the gamification platform with game elements such as points, levels, badges, and the leaderboard. The platform (gamification-learning.com) collected the students' results in CSV files regarding the number of points, badges, levels, and the students' ranking on the leaderboard. The relationship between some variables (game elements) was analyzed as following:

1. The game element points are one of the active game elements in the platform. Students collect the points through performing actions on the platform, such as entering the platform, watching a video, or finishing a specific game. The minimum number of points a student must obtain to get all the badges and pass all the levels is 9000 points. Regarding the result, all the students got points higher than 9000, which indicates that there were many attempts by them to review concepts more than once. Therefore, the correlation of the total points with the number of attempts to review the concepts was analyzed. SPSS software calculated the correlation coefficient using Pearson correlation, and the results were as in Table 5. This table investigates the relationship between two variables: the Points and TopicAttempts. According to Pearson correlation (r), there is a null hypothesis (H0) and an alternative hypothesis (H1) as follows: H0: there is no significant relationship (p) between the Points and ConceptsAttempts when $p > 0.05$. H1: there is a significant relationship (p) between the Points and ConceptsAttempts when $p \leq 0.05$. As a result, the Pearson correlation of the Points and Concepts Attempts was moderately positive and statistically significant ($r = 0.450$, $p < 0.05$). Therefor we reject H0 and accept H1 because this result indicates that an increase in the attempts in the Concepts will increase in points. So, utilizing points in teaching students some concepts in C++ motivate students to try many attempts and thus increase motivation.

Table 5. Correlation coefficients between points and ConceptsAttempts

		Points	**ConceptsAttempts**
Points	Pearson Correlation	1	.450*
	Sig. (2-tailed)		.031
	N	23	23
ConceptsAttempts	Pearson Correlation	.450*	1
	Sig. (2-tailed)	.031	
	N	23	23

Note: *Correlation is significant at the 0.05 level (2-tailed).

2. The number of visits and clicks on the platform are variables by which the Pearson correlation coefficient can be calculated. According to Pearson correlation (r), there is a null hypothesis (H0), and an alternative hypothesis (H1) as follows: H0, there is no significant relationship (p) between NumberOfClicksOnWeb and TimesEnterPlatform when $p > 0.01$. H1, there is a significant relationship (p) between NumberOfClicksOnWeb and TimesEnterPlatform when $p \leq 0.01$. Table 6 shows the results of the Pearson correlation (p) between the variables, which showed a moderate positive association and statistical significance ($r = 0.608$, $p < 0.01$). This result indicates that more visits to the platform will result in more clicks and more points, making the motivation level better. The results are shown in Table 6.

Table 6. Correlation coefficients between NumberOfClicksOnWeb and TimesEnterPlatform

		NumberOfClicksOnWeb	TimesEnterPlatform
NumberOfClicksOnWeb	Pearson Correlation	1	.608*
	Sig. (2-tailed)		.002
	N	23	23
TimesEnterPlatform	Pearson Correlation	.608*	1
	Sig. (2-tailed)	.002	
	N	23	23

Note: *Correlation is significant at the 0.01 level (2-tailed).

3. The leaderboard is one of the game elements present on the educational platform. The platform arranged the students based on the total points. The relationship between the points and the leaderboard was discovered by finding the correlation coefficient. As a result, the Pearson correlation of the Points and leaderboard was strongly negative and statistically significant ($r = 0.450$, $p < 0.05$). This result indicates that an increase in the point will decrease the number related to the leaderboard. The lowest number on the leaderboard is also the highest rank. Leaderboard makes students motivated to be always in the highest rank. Table 7 shows the relationship between Points and Leaderboards.

Table 7. Correlation coefficients between Points and Leaderboards

		Points	Leaderboards
Points	Pearson Correlation	1	–.897*
	Sig. (2-tailed)		.000
	N	23	23
Leaderboards	Pearson Correlation	–.897*	1
	Sig. (2-tailed)	.000	
	N	23	23

Note: *Correlation is significant at the 0.01 level (2-tailed).

In discussing the previous results, the students in the gamification group were able to get better results than the students of the in-person learning group in the post-test. This achievement happened because of the game elements, which are leaderboard, points, badges, and levels provided to the gamification group while learning the concepts of C++. In addition, the possibility for students to repeat the game-exercises of C++ programming concepts-more than once until they get the total score for each game. the results appeared to be positive when analyzing the relationship between the points collected and the number of attempts for each game; the more times attempting, the higher the points. Therefore, Students notice this on the leaderboard, increasing their motivation and engagement to learn more with the educational platform. This relationship proves that the student has a high motivation during learning. Another relationship studied is between the number of accesses to the gamification platform

and the clicks' number on the platform. Positively, the analysis of this relationship appeared. The higher the number of accesses to the platform, the higher the number of clicks, increasing students' points. Points obtained by the student positively affect their motivation and increase their engagement in the lesson. Although this relation proves that the students have a motivation to learn. The last relationship between the points and the release of students' names on the leaderboard showed a strong positive relationship. The student who leads the highest rank on the leaderboard will have the highest total points among her/his peers. Utilizing the leaderboard drives the student to remain in the highest rank through solid engagement in the lesson. As a result, it increases the student's engagement and motivation to get the full mark in all games and thus the post-test.

7 Conclusion and future work

The research investigated the concept of gamification and the narratives of its applications from a chronological perspective. Within this context, the research presented the reasons behind the need to learn through gamification, which directed the study to define its research question. In order to answer the research question, the research developed a Gamification approach on a specific-made educational platform under the URL "gamification-learning.com" to learn programming concepts, which is the language of C++ in particular. This practical approach proceeded through a dual experiment based on learning two different groups of 11th-grade students in a secondary school. The first group engaged with in-person learning, and the second group engaged with gamification learning with; both groups received the same lesson content but through different settings. This experiment aims to discover the effect of learning through gamification on the quality of students' learning and if it can improve their scientific and academic achievement.

After carrying out the research experiment and presenting its tools to students, the researcher interviewed teachers to express their opinion about utilizing the gamification approach to instruct students in C++ programming language concepts. Their answers reveled the extent to which students can utilize gamification in their learning.

Once analyzing the study tools, we found that the academic level of all students was similar in programming skills before starting the learning. After learning through Gamification, the analysis results were positive. We noted that the students who learned through Gamification achieved higher grade average than those who learned through in-person learning with 91.8% and 66.3%, respectively. Moreover, we found that learning through Gamification increases the level of motivation and engagement of students in the lesson, which may positively affect their educational level in addition to the positive impact on the quality of learning, which students acquire by analyzing some of the relationships in the gamification approach such as the relation between points and numbers of attempts in concepts, points and leaderboards, and numbers of clicks on the web and number of times entering the platform.

The results of the questionnaire confirmed the outcomes of the pre-test and post-test analysis. In this context, it illustrated the impact of the game elements. The leaderboard was their favorite element by 60.9%, points by 21.7%, levels by 13%, and

badges by 4.3%. Based on the results we have, exploiting gamification in learning some concepts of C++, the gamification methodology can be taken into consideration to be used as a learning strategy during a pandemic or any crisis.

As a future study, the gamification approach developed and built in this thesis can be applied to a different group of students, such as university students, and learning them other programming languages such as Java and Python. In addition to studying the impact of learning these languages using gamification on students in terms of developing their programming skills and affecting the quality of learning. Furthermore, the participants in the research experiment are female students, so we can conduct research to investigate if the gender affect motivation and engagement in learning.

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9 Authors

Rawan M. Abu-Hammad is a MS student in information systems at King Abdullah II School for Information Technology, Department of Computer Information Systems, the University of Jordan, Amman, 11942, Jordan.

Thair M. Hamtini is a professor with the King Abdullah II School for Information Technology, Department of Computer Information Systems, the University of Jordan, Amman, 11942, Jordan. E-mail: thamtini@ju.edu.jo

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