

# AN EMPIRICAL STUDY ON GAMIFICATION FOR LEARNING PROGRAMMING LANGUAGE WEBSITE

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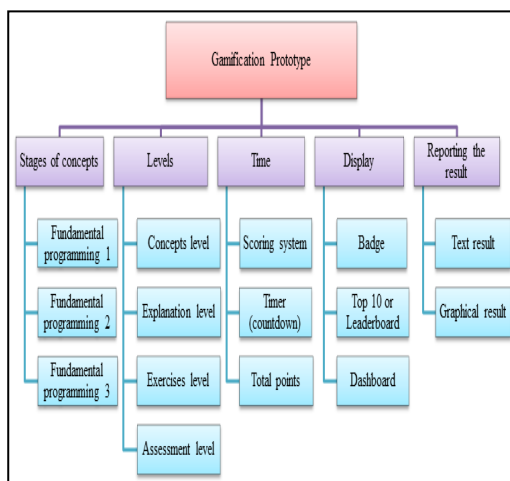
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## Graphical abstract



## Abstract

Computer science novice students find it hard to learn and master programming language subjects. In previous work, an investigation was done to confirm this assumption. The finding showed that students experienced ineffective learning, lacked interest towards this course, and lacked motivation. Previous studies have shown that applying Gamification elements in websites engages users. Gamification refers to the use of game elements in a non-game context in order to increase engagement between human and computer. In priority, a gamification-based learning website for programming language course was developed. This study aimed to measure the effectiveness and motivation level of using a Gamification website for programming language learning for first year students. Quantitative research approach was used. The effectiveness of the gamification website was tested using Quasi experiment. Student motivation was measured using ARCS motivation model. The findings showed that there were significant differences in the overall results of student performance (effectiveness and motivation) between the experimental and control groups.

**Keywords:** Gamification, Game elements, Quasi-experimental method, Programming Language, ARCS motivation model

## Abstrak

Pelajar sains komputer baharu mendapati sukar untuk belajar dan menguasai kursus pengaturcaraan. Dalam kajian lepas satu penyiasatan awal dilakukan bagi mengesah andaian ini. Hasil kajian menunjukkan pelajar mengalami pengalaman pembelajaran yang kurang berkesan, kurang minat terhadap kursus tersebut dan kurang bermotivasi. Kajian lepas juga mendapati dengan mengaplikasi elemen gamifikasi dalam laman web, keterlibatan pengguna meningkat. Gamifikasi dirujuk sebagai penggunaan berbagai elemen permainan dalam konteks bukan permainan bertujuan untuk meningkatkan keterlibatan antara manusia dan computer. Sebelum ini, laman pembelajaran kursus bahasa pengaturcaraan berasaskan gamifikasi dibangunkan. Kajian ini bertujuan untuk menguji keberkesanan dan tahap motivasi pelajar tahun satu setelah menggunakan laman web gamifikasi pembelajaran pengaturcaraan. Pendekatan kuantitatif digunakan. Ujian keberkesanan laman web gamifikasi dilaku menggunakan kaedah eksperimen Quasi. Tahap motivasi pelajar diukur menggunakan model motivasi ARCS. Hasil kajian menunjukkan terdapat perbezaan yang signifikan dalam keseluruhan keputusan analisis terhadap

pencapaian pelajar (keberkesanan dan motivasi) antara kumpulan eksperimen dan kawalan.

*Kata kunci:* Gamifikasi, elemen permainan, Quasi-eksperimen, Bahasa Pengaturcaraan, instrument ARCS

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## 1.0 INTRODUCTION

Gamification is a process of game thinking and game mechanics that engages users to use computer application. Gamification refers to the use of game elements in a non-game context in order to increase engagement between humans and computers and to solve problems effectively [1, 2, 3, 4, 5, 6, 7, 8]. [9] argues that Gamification can be thought of as using pieces of games to motivate learners, but the real definition of Gamification involves using game-based mechanics, aesthetics, and game thinking to engage users, motivate action, promote learning, and solve problems. [10] predicted that by 2015, more than 50% of organizations that manage innovation processes will gamify those processes.

Gamification is an integral part of an application because it can ensure the effectiveness of its usage, as demonstrated by [11]. Within a learning environment, the benefits of Gamification elements cannot be ignored because the main goal is to increase user effectiveness, and understanding through fun and enjoyable learning thereby yielding high user performance. Based on the results of [11], this research tries to solve the problem through a Gamification approach to verify the effectiveness of applying a Gamification approach to students especially in difficult subjects such as Programming Language courses (i.e., HTML, CSS, SQL, Visual Basics, C++/Java, and Machine Language).

Several research [12, 13] have attempted to make computer programming fun, students motivated and increase students' performance. [14] mentioned that reducing the difficulties of students in understanding the concepts, and rules of a programming language can enhance their motivation and competency to learn the course. Some popular problems that students face in learning programming languages are:

1. Memorizing reserved words in code writing is the greatest difficulty faced by old and novice students. Students find texts with unfamiliar grammar rules, and syntax written in a language foreign to them.
2. Writing the syntax code of programming languages can be frustrating especially for

students who are new to the course [15, 16, 17, 18, 19].

3. Learning basic algorithms [20].
4. Learning formal programming [21].
5. Students tend to focus on trivial things instead of concentrating on the essential ones [22].
6. Many teaching materials used by teachers and lecturers at the university reduced the essential issues of programming courses. This circumstance has led to bad coding habits that have caused students to unintentionally write poor code from the beginning [23].
7. Difficulty in understanding how to debug problems [24].
8. Insufficient time for learning and lack of motivation [25].

These findings revealed problems that make Programming Language an uninteresting course for students. Several researchers [13, 14, 15, 16, 17, 22, 26, 27, 28, 29, 30] have tried to solve these issues by employing different methods, such as Web-Based Java Programming Language, 3D animation, mobile learning application, game-based learning, and visualization. [13, 14, 22, 26] elucidated that an approach that could be easily understood and implemented in an enjoyable manner must be invented for the of learning difficult subjects.

Therefore, this research proposed the use of a Gamification technique to solve the specified problems in Programming Language learning. This approach requires the use of game elements in a learning context to increase engagement between human and computer [1, 2]. The purpose of this research is to develop a gamification-based learning, learning website for programming language. In priority, a gamification model for learning programming language course was constructed. In order to verify the gamification-based programming learning model a prototype was developed. Several testing were employed to evaluate the prototype in order to indirectly validate the model. Expert inspection methods to evaluate the usability of the website were conducted during the development process. Upon completion of the prototype development, several tests to real users were done. In this paper, the process, and outcome of real users

testing is reported. The objective of this paper is to measure students effectiveness and motivation when using this prototype. This paper is structured in several sections. First, the constructed gamification-based learning programming language model, and prototype are presented. In the following section the material and methods of this study are discussed, followed by the outcomes of study, the discussion of evaluation result, and finally the conclusion with the limitation of this study.

### 1.1 Related Works

In principle, electronic learning that is delivered via computer is called e-learning. For instance, in the academic field, e-learning refers to the teaching strategies employed by a university, or school network. [31] mentioned the importance of e-learning in their study, in which they considered e-learning as a learning motivation tool for students in universities. In the fast-paced world of e-learning, the available technologies for making a course new and exciting are always changing, so that the course content can, and should be updated quickly to equip students with the most recent information. This is particularly important in the case of e-learning involving students in a sector that prioritises, and demands up-to-date learning developments. There are three types of e-learning: text-driven, interactive, and simulation. Simulation in e-learning is highly interactive and relies heavily on graphics, video, audio, and some game-like elements (Gamification) [32].

Gamification refers to the use of game elements (game design, game thinking) in a non-game context to improve user experience and user engagement in non-game services and applications such as marketing application used points cards and rewards memberships, and in educational structures mostly used such as levels, grades, and degrees [2]. [33] defined gamification as a process of game thinking, and game mechanics that engages users, and solves problems. [34] argue that gamification can be thought of as using pieces of games to motivate learners, but the real definition of gamification involves using game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems. Lastly, [35] pointed out that gamification in e-learning is fast emerging as an effective learning technique for students.

The gamification technique solved some problems concerning learning materials from kindergarten to university level [60]. [10] predicted that in the future more than 50% of organisations that manage innovation processes would gamify these processes. In general, by 2014, a gamified service for marketing of consumer goods, and customer retention had become as important as Facebook, eBay, or Amazon, and more than 70% of Global 2000 organisations have at least one gamified application [10].

In the e-learning world, technology is evolving rapidly to include computer games, movies, and all types of digital media. Companies are doing their best to attract the attention of young people using the latest technologies. However, it is of importance to recognise the challenge that this situation poses for teachers. With the emergence of new technology, attracting the attention of students poses a colossal challenge, especially at the undergraduate level where technical subjects are taught, for which teachers must motivate students to learn within a limited time [36]. Some examples of technical subjects such as Field-programmable Gates, Mathematics, and Image Processing [37, 38], manufacturing technologies [39], and information and communications technology [40].

Technical subjects are often complicated and complex. These subjects demand logical thinking and imagination. One method to simplify the learning process is the use of illustrative examples of the real process [41]. [42] found one way to make students interact better and increase their interest in learning, particularly technical subjects, which was to conduct laboratory sessions. This means that the student would be able to manipulate objects on a computer screen using the keyboard or mouse, and then see in real-time the outcomes of their actions. For more than three years, [38] investigated methods to increase student interest in technical subjects, targeting secondary schools and universities. They discovered the reasons for poor student performance in technical subjects were lack of motivation, and loss of interest.

The brief literature review above summarises two main problems of learning technical subjects: loss of interest, and lack of motivation, by students. These two main problems have made learning of these technical subjects ineffective. The first problem, which is loss of interest by students, was addressed in the studies of [38, 40, 42]. Each attempted to solve this problem using a different approach. One example is the use of a mobile platform, the outcome of which allowed the student to manipulate objects on a computer screen. The second problem, the loss of motivation, was addressed in the works of [40, 31], in which they also attempted to solve the problem using a mobile platform. Using this platform, they considered e-learning as a motivational tool for university students.

When it comes to online learning in the education field, the model has been pretty straightforward - up until the early 2000s, education was conventionally conducted in a classroom with a teacher leading the process. In 2014, one study suggested that e-learning be used as an assistive tool for technical subjects [43]. [44] stated that elements of multimedia can contribute and support the instruction of technical subjects. Additionally, in their study, [45] explained a method for learning technical subjects specifically in the field of electronic engineering, in which students must be well-versed with the concepts of the subjects besides having to attend laboratories. [40] used a

mobile platform to increase student interest in studying technical subjects pertaining to Information and Communications Technology.

Gamification refers to applying several game elements in different domains [46], and for use in several areas, such as in education and learning, health and science; and some usage of gamification are explained in the following subsections.

### 1.1.1 Gamification in Learning

Microsoft is one of the giant companies that has invested in game mechanics to support the learning of Software Engineering [47]. [48] used CodeSmellExplorer for the general construction of a code, and its overall logical design, wherein he focused on creating a simple and easy-to-use code to support Software Engineering. [48] also used an extract refactoring node code method to analyse the main factor, and several other sub-factors (and their representations) in the form of graphics/schemes, which, in turn, facilitated the writing of code for undergraduate students, and helped improve the production of engineering learning programs. Such improvements ultimately enabled students to successfully learn the principles of professional programming.

In the domain of Human-Computer Interaction, adding a game element to applications, specifically mobile applications, can lead to increased user engagement. For example, a mobile application to help new undergraduate students familiarise themselves with the university facilities is an important tool that can be used by students [49]. However, the following aspects must be considered in designing such applications: (1) adding an element that makes the application easier to use even for students who are inexperienced with modern technology; and (2) striking a balance between being user-friendly and fun. These two aspects could change outcomes, such as effectiveness and motivation.

According to [11], a method that removed gamification from social networks can lead to the following effects: (1) decreased user engagement; (2) decreased user participation; and (3) decreased student achievement. In other words, not using gamification in designing an application can lead to an unsuccessful application, especially in terms of user engagement and learning. For example, in the academic field, the benefits of gamification elements cannot be ignored because the main goal is to increase effectiveness and understanding within a fun and enjoyable learning environment, thereby yielding high user productivity. To summarise, [11] observed the impact of the removal of the points system as a gamification feature within a social networking system, which resulted in a significant negative impact on user activity of the site, and he suggested that the contribution of content significantly decreased after the deactivation of the points system. In view of [11], this study can conclude

that, the effectiveness of deploying only one game element.

### 1.1.2 Game Elements in Gamification

According to [50] and [51], games have two main elements, namely, game mechanics and game dynamics, as shown in Table 1. The most used game elements in previous work were Badge and Points system.

Table 1 Game elements

Game mechanics	Game dynamics
Points	Rewards
Levels	Status
Badge achievement	Achievement
Virtual goods	Self-expression
Leaderboard	Competition
Virtual gifts	Altruism

As social networks became popular applications they gave rise to social games. The concept of gamification is the use of elements from social games in non-game applications [50]. Examples of social game elements can be found in game mechanics [52]. The social learning environment will support such content, and allow the teacher to choose the appropriate social gamification tools, based on game-like elements from social games in order to promote certain desired behaviours.

Therefore, this study focused on the effectiveness, and motivation of these elements, when embedded in student learning material namely programming language course. The subsequent section explains the methodology of measuring two dimensions such as the effectiveness of using gamification website, and student motivation after using it.

## 2.0 METHODOLOGY

In priory, a gamification model was constructed according to student preferences. Based on the model, a gamification prototype was developed. Upon completion, the prototype was tested for its effectiveness in learning programming. In addition, student motivation level was measured.

### 2.1 Gamification Learning Prototype

The gamification prototype has five attributes, as shown in Figure 1. The first attribute is called "stages", and is distributed based on elements in the syllabus of fundamental programming subjects, such as Fundamental Programming 1, Fundamental Programming 2, and Fundamental Programming 3, to cover all of the concepts in the Fundamental Programming Language subjects for a Bachelor's degree programme. The second attribute is called "levels". This attribute has four elements for each

concept or sub-concept, including a concept level, an explanation level to explain how to use this concept, and an exercise level to provide more examples for each concept to enhance student understanding.

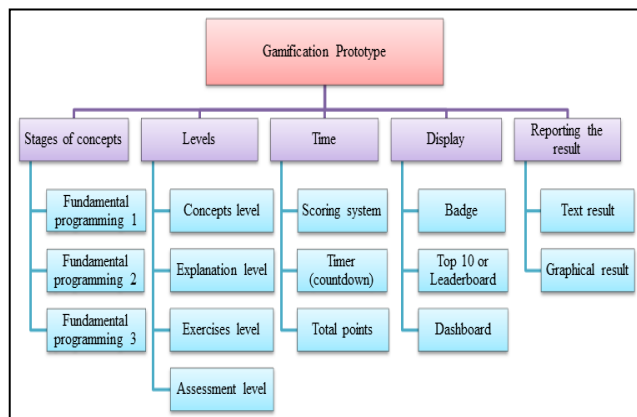


Figure 1 Gamification prototype

The last level is an assessment level, which is designed to evaluate whether the students have understood certain concepts using multiple-choice questions. The answers to these questions were timed (third attribute). The third attribute has an element called the scoring system, which calculates the total points for all the questions. Based on the total points accumulated, each student in the display step will obtain a Badge based on the total points and rank, to be displayed on the Leaderboard. The Top 10 also appears on the dashboard to show all the points scored for each concept. The last attribute, called "reporting", shows a report for the total learning progress of each student, and describes whether the student will proceed to the next level, or stage whilst also presenting the student's learning progress in the form of a graphical diagram.

This is an empirical study whereby empirical evidence is used to show that using gamification learning material is effective, and increases student motivation. This study is a way of gaining knowledge by means of a quasi-experiment. Accurate analysis of data using standardized statistical methods is used to determine the validity of empirical research. Our underlying assumption is that a gamification approach with the learning prototype can support student learning. This section presents the research questions of the experimental design, instruments to test our hypothesis, and to collect data.

**Study site:** The research was conducted at the Faculty of Information Science and Technology, University Kebangsaan Malaysia, during semesters 1 and 2 of the 2013/2014, 2014/2015, and 2015/2016 academic sessions. The courses used traditional teaching approaches; lecture, tutorial, and laboratory. Students had six hours of lectures, and

four hours of lab per week in order to apply what they had learned during the lecture. In total, students spent around 140 notional hours learning the course. The contents of Computer Programming Course are an introduction to Java 1 and 2; objects: OOP concepts; flow control - repetition structure; flow control: conditional; data type and operators; arrays and array processing parts 1 and 2, and input & output with problem solving.

### 2.1.1 Quasi-Experiment

The purpose of this experiment was to evaluate the effectiveness of gamification learning website. The sampling, instrument, and method used are discussed. A quasi-experimental method was used to evaluate the effectiveness of gamification prototype. This study was divided into three stages: pre-test, treatment session, and post-test. In the first stage, a pre-test was administered to all groups. All samples had to undergo the pre-test to ascertain their previous knowledge of the programming language concepts. The objective of this stage was to accumulate, and assess students' scores. The second stage involved the treatment session where all groups were taught conventionally by lecturers in the classroom. Meanwhile, the experimental group continued learning using gamification web site while the control groups learned using conventional method. Finally, in the third stage all samples were given the post-test. The objective of this post-test is to measure the students' knowledge of the programming language knowledge after the treatment session by the score they obtained. Five lecturers were involved in evaluating the students' test.

In this faculty, the new students come from different pre-university programmes; STPM, STAM, Matriculation 1, Matriculation 2, and Matriculation 3. The first group of students from STPM, STAM, and Matriculation 1, has never taken any programming language course, and are grouped into the experimental group, and control group 1 with 30 students in each group. The remaining 30 students who had taken a programming language course in the pre-university programme (Matriculation 2 and 3) were selected as control group 2.

**Sample:** The experiment was conducted with 90 students (new students registered in September intake 1(2015/2016). The students were assigned to three groups of 30 each; experimental group (Eg) (use gamification application with conventional teaching method, and they had never learned any programming language), control group 1 (Cg1) (conventional teaching method only, and they never learned any programming language), control group 2 (Cg2) (conventional teaching method only, and they had already learned programming language).

**Instrument:** A programming test which consists of 30 multiple-choice questions was used for the pre, and

post-tests. All questions in both tests are similar, but arranged in a different sequence. A pilot test to determine the validity, and reliability of the instrument was carried out on 30 students, and five programming course instructors. The Content Validity Ratio (CVR) for the instrument was +1.00. CVR is a method used to test the content validity of the instrument using the formula  $CVR = (2ng / N) - 1$ ; ng = number of experts who gave positive grading for the instrument items, and N = total number of experts. The reliability of the instrument was measured using Cronbach Alpha Coefficient test. The values of Alpha for the thirty questions were greater than 0.7, which indicates that the questions are reliable.

**Research Hypothesis:**

The effectiveness evaluation of gamification application was to test the following hypothesis.

1. Hypothesis H01: There is no significant difference between pre and post-tests mean scores for the experimental group.
2. Hypothesis H02: There is no significant difference between pre and post-tests mean scores for control group 1.
3. Hypothesis H03: There is no significant difference between pre and post-tests mean scores for control group 2.
4. Hypothesis H04: There is no significant difference in overall result between the samples who learn using gamification application and those using conventional teaching method (control group 1).
5. Hypothesis H05: There is no significant difference in overall result between the samples who learn using gamification application and those using conventional teaching method (control group 2).

Figure 2 shows a summary of all hypotheses for effectiveness evaluation.

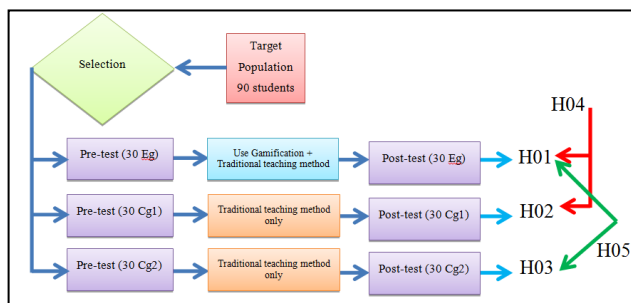


Figure 2 Effectiveness hypothesis

**2.1.2 Motivation evaluation (ARCS model)**

The purpose of this ARCS motivation instrument was to evaluate student motivation, before, and after using gamification learning website. This motivation evaluation was divided into three stages: pre-test,

treatment session, and post-test; similar with the effectiveness test. For this evaluation, the same samples that were used for effectiveness evaluation was employed.

**Instrument:** Two sets of motivation test consist of 28 questions with four factors, Attention, Relevance, Confidence, and Satisfaction of ARCS motivation model. All the questions in both tests were similar, but arranged in a different sequence. A pilot test to determine the reliability of the instrument was carried out on 30 students. The reliability of the instrument, using Cronbach Alpha values for 28 questions were greater than 0.7.

**Hypothesis:** The motivation instrument was to test the following hypothesis.

1. Hypothesis H06: There is no significant difference in motivation level between pre and post-tests for the experimental group.

Figure 3 shows all hypothesis of motivation evaluation.

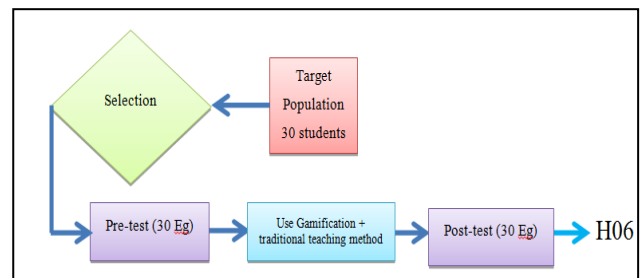


Figure 3 Motivation hypothesis

**3.0 RESULTS AND DISCUSSION**

In this section, the findings of the effectiveness and motivation evaluation are presented. The discussion of the results is also explained.

**3.1 Effectiveness Result**

The results of the pre-test and post-test for each student in all groups are shown in Table 2.

Table 2 Pre-test and post-test results for all students

Student ID	Pre test	Post test	Student ID	Pre test	Post-test	Student ID	Pre test	Post-test
Eg-1	1.0	27.0	Cg1-1	.00	17.0	Cg2-1	14.0	22.0
Eg-2	.00	29.0	Cg1-2	5.0	19.0	Cg2-2	16.0	19.0
Eg-3	2.0	27.0	Cg1-3	8.0	22.0	Cg2-3	22.0	30.0
Eg-4	4.0	28.0	Cg1-4	7.0	25.0	Cg2-4	15.0	22.0
Eg-5	2.0	29.0	Cg1-5	4.0	15.0	Cg2-5	8.00	22.00
Eg-6	6.0	28.0	Cg1-6	8.0	20.0	Cg2-6	15.0	17.00
Eg-7	9.0	28.0	Cg1-7	5.0	20.0	Cg2-7	22.0	26.00
Eg-8	8.0	30.0	Cg1-8	9.0	22.0	Cg2-8	17.0	21.00
Eg-9	7.0	28.0	Cg1-9	4.0	15.0	Cg2-9	14.0	20.00
Eg-10	4.0	29.0	Cg1-10	2.0	21.0	Cg2-10	11.0	19.00
Eg-11	2.0	30.0	Cg1-11	7.0	19.0	Cg2-11	15.0	23.00
Eg-12	8.0	30.0	Cg1-12	5.0	22.0	Cg2-12	5.0	15.00
Eg-13	9.0	29.0	Cg1-13	8.0	22.0	Cg2-13	10.0	17.00

Student ID	Pre test	Post test	Student ID	Pre test	Post test	Student ID	Pre test	Post test
Eg-14	4.0	30.0	Cg1-14	5.0	22.0	Cg2-14	9.0	24.00
Eg-15	9.0	30.0	Cg1-15	8.0	16.0	Cg2-15	11.0	30.00
Eg-16	4.0	27.0	Cg1-16	6.0	15.0	Cg2-16	12.0	23.00
Eg-17	5.0	27.0	Cg1-17	8.0	15.0	Cg2-17	12.0	26.00
Eg-18	9.0	28.0	Cg1-18	2.0	15.0	Cg2-18	15.0	27.00
Eg-19	5.0	28.0	Cg1-19	3.0	19.0	Cg2-19	19.0	29.00
Eg-20	2.0	30.0	Cg1-20	4.0	16.0	Cg2-20	15.0	19.00
Eg-21	.00	28.0	Cg1-21	9.0	22.0	Cg2-21	14.0	19.00
Eg-22	6.0	29.0	Cg1-22	8.0	21.0	Cg2-22	14.0	22.00
Eg-23	2.0	30.0	Cg1-23	1.0	20.0	Cg2-23	22.0	25.00
Eg-24	8.0	27.0	Cg1-24	4.0	16.0	Cg2-24	13.0	15.00
Eg-25	9.0	30.0	Cg1-25	3.0	19.0	Cg2-25	9.00	15.00
Eg-26	2.0	28.0	Cg1-26	5.0	23.0	Cg2-26	23.0	30.00
Eg-27	5.0	27.0	Cg1-27	.00	25.0	Cg2-27	25.0	28.00
Eg-28	7.0	29.0	Cg1-28	.00	22.0	Cg2-28	19.0	21.00
Eg-29	4.0	29.0	Cg1-29	3.0	15.0	Cg2-29	18.0	19.00
Eg-30	1.0	29.0	Cg1-30	5.0	17.0	Cg2-30	20.0	20.00

Note: Eg refers to Experimental group, Cg1 refers to Control group 1 and Cg2 refers to Control group 2

Based on the results from Table 2, to compare the difference between pre-test, and post-test scores, the paired t-test was conducted. The results are shown in Tables 3 and 4.

Table 3 Paired t-test for all groups

Pre - Post	Mean	Std. Deviation	t	Df	Sig. (2-tailed)
Eg	-23.80	3.06	-42.50	29	.000
Cg1	-14.36	3.96	-19.86	29	.000
Cg2	-7.03	4.58	-8.39	29	.000

Table 4 Mean score for all groups

		Mean	Std. Deviation
Eg	Pre-Eg	4.80	2.97
	Post-Eg	28.60	1.10
Cg1	Pre-Cg1	4.86	2.75
	Post-Cg1	19.23	3.16
Cg2	Pre-Cg2	15.13	4.86
	Post-Cg2	22.16	4.54

The paired-t test shows that there is a significant difference in the scores for pre-test (Eg) (Mean=4.80, SD=2.97), and post-test (Eg) (Mean=28.60, SD=1.10) conditions:  $t(29)=-42.50$ ,  $p < 0.0001$  for the experimental group. This means that there is a significant change in knowledge using conventional teaching method, and using the Gamification application that resulted in the rejection of H01.

Similarly, H02 is rejected. There is a significant difference in the scores for pre-test (Cg1) (Mean=4.86, SD=2.75), and post-test (Cg1) (Mean=19.23, SD=3.16) conditions:  $t(29)=-19.86$ ,  $p < 0.0001$  for control group 1. This indicates that there is a significant change in knowledge gain for students in Cg1, who were taught using conventional teaching methods only, and had never learned programming language before.

H03 is also rejected. There is a significant difference in the scores for pre-test (Cg2) (Mean=15.13, SD=4.86), and post-test (Cg2) (Mean=22.16, SD=4.54) conditions:  $t(29)=-8.39$ ,  $p < 0.0001$  for control group 2. This means that there is a

significant change in knowledge gain for students in Cg2, who were taught using the conventional teaching method only, and had already learned a programming language before.

The results of the independent t-test for H04 are presented in Tables 5 and 6. In relation to H04, there is a significant difference in the post-test score of the Eg group (Mean=28.60, SD=1.10), and Cg1 group (Mean=19.23, SD=3.16) conditions:  $t(58)=15.28$ ,  $p < 0.0001$ . This means that learning using the Gami-PL has been proven to be effective in increasing the students' knowledge when learning programming language concepts.

Table 5 Results of the independent t-test for group statistics (Eg, Cg1)

	Use Gamification	Mean	Std. Deviation	Std. Error
Post-test	Eg	28.60	1.10	.20
	Cg1	19.23	3.16	.57

Table 6 Results of the independent t-test between Eg and Cg1

	t	df	Sig. (2-tailed)	Std. Difference	Error
Pre-test	-.090	58	.929	.73	
Post-test	15.28	58	.000	.61	

Based on results of the independent t-test for H05 presented in Tables 7 and 8, there is a significant difference in the post-test score of Eg group (Mean=28.60, SD=1.10), and Cg2 group (Mean=22.16, SD=4.54) conditions:  $t(58)=7.52$ ,  $p < 0.0001$ . The conventional teaching method is not enough to increase students' knowledge of the concepts, thus it is an inefficient method to learn programming language. Finally, this means that the Gami-PL is effective in increasing learning programming language capacity amongst students.

Table 7 Results of the independent t-test for group statistics (Eg, Cg2)

	Use Gamification	Mean	Std. Deviation	Std. Error
Post-test	Eg	28.60	1.10	.20
	Cg2	22.16	4.54	.83

Table 8 Results of the independent t-test between Eg and Cg2

	t	df	Sig. (2-tailed)	Std. Difference	Error
Pre-test	-9.92	58	.000	1.04	
Post-test	7.52	58	.000	.85	

	t	df	Sig. (2-tailed)	Std. Difference	Error
Pre-test	-9.92	58	.000	1.04	
Post-test	7.52	58	.000	.85	

Our observation shows that the participants from the Experimental group were enthusiastic about using the Gamification website. This group did not stop using the Gami-PL, and instead continued until the end. In this group, 76.67% of the participants tried to use the website until the end, and 60% tried to use the website again in order to reduce the time they needed to answer the questions (Countdown). At the pre-testing stage, all samples (the Control groups and Experimental group) appeared bored when asked to answer the 30 test questions. They finished answering the questions within one hour. On the other hand, participants from the Experimental group looked interested and happy when using the Gami-PL during the treatment session because they liked being able to directly see their results as well as seeing their name highlighted on the Top 10 list, or Leaderboard. In the post-test stage; participants in the experiment group finished the test faster and showed no signs of disinterest, compared to participants in the two Control groups. They also looked at ease when completing the test.

### 3.2 Motivation Result

This section discusses the findings regarding the motivation evaluation. The purpose of the evaluation was to measure students' level of motivation before, and after using the Gamification website.

The purpose of the paired t-test was to see whether there is a significant difference between the pre-test and post-test scores of motivation. The results are shown in Tables 9 and 10.

Table 9 Motivation mean score

		Mean	Std. Deviation
Eg	Pre-Eg	1.49	.45
	Post-Eg	4.60	.44

Table 10 Result of paired t-test on motivation scores of Eg

Pre - Post	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Eg	-3.11	.66	-25.65	29	.000

The paired-t test showed that there is a significant difference in the scores for pre-test (Eg) (Mean=1.49, SD=.45), and post-test (Eg) (Mean=4.60, SD=.44) conditions:  $t(29)=-25.65$ ,  $p < 0.0001$  for the experimental group. This means that there is a significant change in motivational gain for participants in the experimental group, who were

taught using the conventional teaching method, and the Gamification application. Thus H06 is rejected.

### 3.3 Discussion of Evaluation Results

Based on the findings, the Gami-PL is effective, and could help increase students' achievement in learning a programming language. It can be used to address their lack of interest in learning the programming language subject, which has contributed to low marks, as stated in previous works [53, 54]. This website can be used as an effective tool in-line with conventional teaching methods for learning programming language. The overall effectiveness scores (pre and post-test) across the groups are illustrated in Figures 4 and 5.

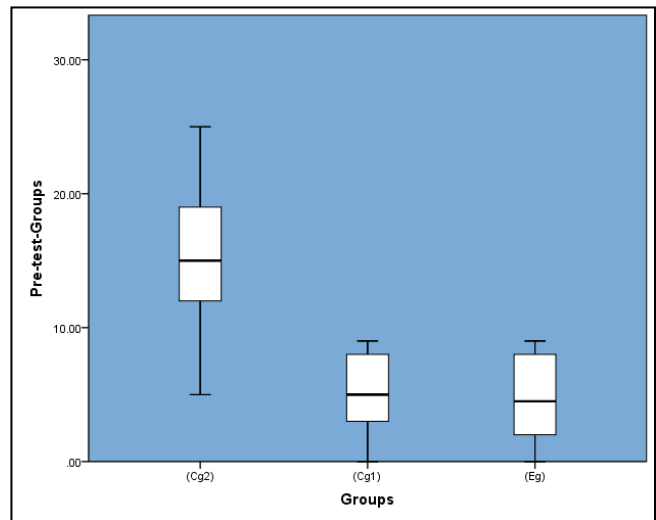


Figure 4 Overall pre-test effectiveness evaluations

Figure 4 shows the overall pre-test evaluations of the groups based on the marks of each student. The mark range for Cg2 was 11 to 19, as they had learned a programming language before. However, the mark range for Cg1 and Eg, was 3 to 9 for the pre-test because they had never learned programming language before. However, the results differ greatly in the post-test, as shown in Figure 5. The range for Cg2 is 19 to 26, and 16 to 22 for Cg1. However, when Eg used the Gamification website, the range for Eg was between 25 and 30 for the post-test. This website can therefore be used as an effective tool together with conventional teaching methods for learning a programming language subject.



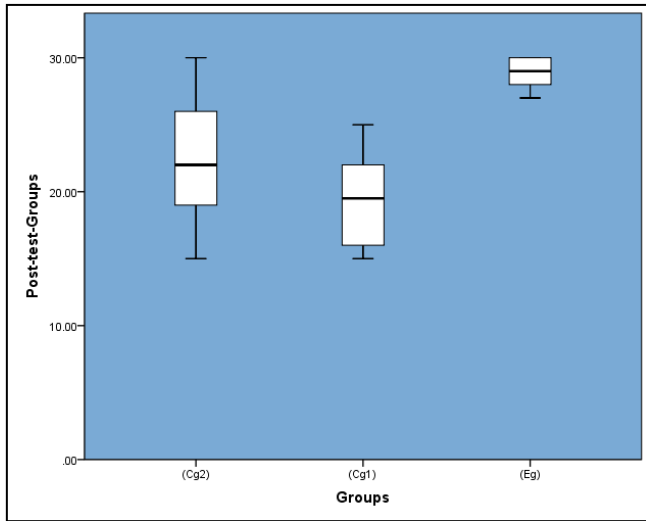


Figure 5 Overall post-test effectiveness evaluation

This means that the Gami-PL can increase user interest in learning a programming language. Additionally, for the finding regarding motivation, the Gami-PL does indeed motivate students, and could be used as an effective learning environment tool together with conventional teaching methods for learning a programming language subject to motivate students. Moreover, this finding is similar to results of previous works [55]; [56], which demonstrated that learning technology positively correlates with learning outcomes. Finally, it is also demonstrated that the learning outcomes of students are significantly related to their learning motivation.

This result is compatible with the studies of [55] and [56], which state that the use of learning technology positively correlates with learning outcomes. According to Su and Cheng [55], motivation theorists have long agreed that those who are more interested, and engaged in the process of education will learn better, and achieve more. The results of this research indicate that intrinsic motivation can change learning achievement based on the game elements. When learning activities arouse students' curiosity and interest, and students are satisfied with the system's function in an educational environment; these students can reach a greater level of learning motivation and attain a higher learning achievement. Similarly, [57] found that learning motivation has a strong positive effect on learning outcomes.

A comparison of the outcomes for the effectiveness and motivation of the experimental group is shown in Figures 6 and 7. Figure 6 presents the experimental group based on the outcomes of the pre-test motivation on the X-axis, and pre-test effectiveness on the Y-axis. Therefore, the range of marks for each student in the experimental group is between 0 and 2 on the X-axis, and 0 and 10 on the

Y-axis because this group had never learned programming language before.

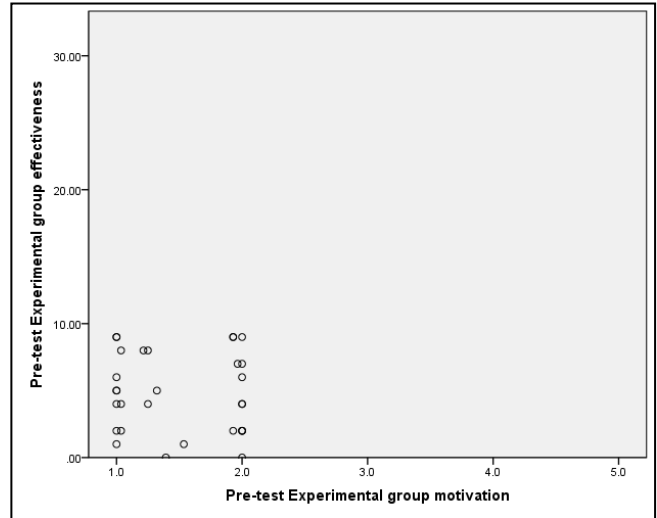


Figure 6 Pre-test experimental group performance

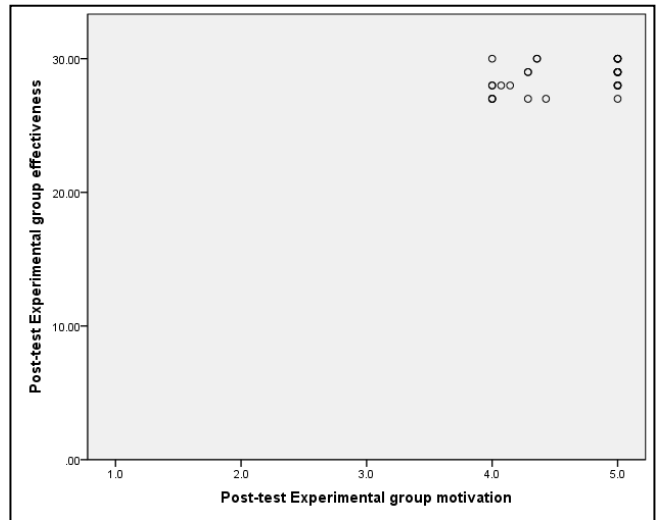


Figure 7 Post-test experimental group performance

However, the performance in the post-test is markedly different, as shown in Figure 7: the experimental group was between 4 to 5 on the X-axis, and 26 to 30 on the Y-axis. Thus, the Gami-PL could be used to increase student performance when learning a programming language subject.

Finally, in research closely related to this study, [58] used a gamification technique to improve student engagement in learning. The evaluation results showed a positive effect on student engagement in gamified learning activities, and a moderate improvement in learning outcomes. However, the authors should have mentioned whether the respondents were new students because an experienced or advanced student would already know the basic concepts of C programming language [59, 60, 61, 62].

## 4.0 CONCLUSION

This study mainly focused on how to validate gamification websites. The effectiveness of gamification prototype is tested by using a quasi-experimental method. In addition, this prototype has increased students' motivation.

Gamification prototype was developed for use by students in the subject of programming language as a learner, particularly used for self-learning, and assessment of their level of knowledge. On the other hand, this prototype could be used for other subjects such as database, chemistry; just they need to upload the learning content of the particular subjects.

The main contribution is the empirical studies that have been carried out through gamification website to measure the effectiveness on student learning the concepts of programming language. Comprehensive empirical study includes descriptive analysis that was used to test the hypothesis between all groups, as well as motivation evaluation in order to measure the relationship between student motivation, and student achievements by correlation analysis.

This gamification website led to an increase in the effectiveness and motivation of the students when they learned programming language, but the results and the findings might be different if applied to other Malaysian students in a different university, or if applied to students from different nationalities. Therefore, my recommendation for those who are interested in doing further research is to apply the gamification application to students of different nationalities, and then compare results to results of the Malaysian students in this study. On the other hand, this research studied only new students in the Department of Computer Science, so my recommendation is to apply the research to students with more advanced levels to see if the results might be different or stays the same. Finally, this research used the same learning content of traditional teaching method, so my recommendation is to use different materials such as video, and/or animations in order to see if the results might be different or stay the same.

Finally, this study selected a group of first year undergraduate students enrolled in the Information Technology and Computer Science Faculty as a sample in order to measure learning effectiveness and motivation. Therefore, the findings of this study are limited to students with the same level of knowledge.

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