Gamification in Programming: Does Gamification Increase Student's Motivation?

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Abstract:

This study aims to investigate the effect of gamification on student motivation for Basic Programming course offered to Diploma of Digital Technology'students in one of the Polytechnics in northern Malaysia. This study was conducted to investigate the students'motivation through the approach of gamification compared with the students' motivation through the existing learning method without the application of gamification. The design of this study was quasi-experimental and it was divided into two groups namely the control group and the experimental group. Student motivation was measured using the questionnaire adapted from the ARCS Model (Attention, Relevant, Confidence and Satisfaction) by Keller. The duration of treatment given to the student was three weeks and the sample consisted of sixty students. The results from the t-test analysis showed that there were significant differences in student motivation before and after receiving treatment and students in gamified learning approach was motivated than those in non-gamified learning approach. Overall, this result proves that gamification to have a good impact on student motivation and further research is needed to explore more on the implementation of gamification in a classroom with longer duration by focusing on the application of specific game elements and investigate its effectiveness.

Key words: *Gamification, Motivation, Programming*

INTRODUCTION

The current situation shows gamification has emerged and become a popular trend [1][2][3] where many gamified applications were developed within different fields such as finance, health, education, marketing, business as well as entertainment [2][3]. The term gamification has been defined in several ways, such as Deterding et. al. [4] defines gamification as "the use of game design elements in non-game contexts". Whereas according to Hamari, Koivisto and Sarsa,[5] gamification is "the phenomenon of creating gameful experiences". Kapp [6] defines gamification as the use of "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems".

Recently, educators have begun discovering the possibility of making the class itself a game by applying gamification [1]. Students could be motivated to learn new ways or enjoy participating in the class and doing the tasks as gamification has the potential as an innovative teaching tool that should be applied to nowadays generation students [7][8]. Motivation is amongst the important factors influence student academic achievements, which impacts their effort and time they spend engaged in learning [9]. In education, motivation is considered a determining factor of learning that is used to explain the attention and effort students commit to particular learning activities [10]. Nature of games is believed may facilitate students' motivation and interest, engagement, as well as the retention of learned skills [11]. It is where the game characteristics and mechanics are incorporated into a task to promote change in behaviour [12]. The idea behind the gamification concept is using elements of games in non-game situations in order to motivate people to do

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things they might not otherwise do or enjoy doing. This concept that has been successfully utilized in other fields such as business and marketing and frequently used to motivate and engage people, and is now being implemented by many educators [3], [12].

Basic Programming is a compulsory core subject for Diploma of Digital Technology's students (DDT). This course introduces the basic concepts of programming structure thoroughly based on problem-solving. Problem-based learning and practical training are also the foundation of the development of students' skills in mastering Basic Programming courses in the construction of problem-solving programs. Students are emphasized on applying logical thinking in solving computer problems, involving logical manipulation by applying concepts and theories such as Selection, Looping, and Struct. This includes the concept of algorithms and their implementation in the structure of the program including functions, structural data, indicators and data types. However, not all students can easily understand the concepts of these functions and arrays [13].

Greenberg and Baron [14] defines motivation as a process that encourages, directs, maintains human behaviour towards achieving a goal. In the context of this study, motivation is a process to promote certain behaviour in order to achieve a certain goal [13]. In this study, motivation refers to the use of application of quiz using gamification which was known as Learn C ++ and the non-gamification quiz application in teaching and learning process to investigate the effect of student motivation for Basic Programming course. The theoretical framework used to support this research is the ARCS Motivation Model by Keller (Attention, Relevant, Confidence and Satisfaction) [15] to assess the students' motivation in quiz application usage.

THEORETICAL FRAMEWORK

ARCS Model

ARCS Model consists of four components namely Attention, Relevance, Confidence and Satisfaction. Each component in the ARCS Model plays an important role in motivating students during the learning process. The ARCS model has been widely used in designing the teaching materials because this theory of motivation is closely related to the development of teaching and learning process [16].

Fig 2 ARCS Model by Keller [15]

The followings are the ARCS Model components used in this study:

1) Attention refers to the response and motivation of students to start the learning process based on the instructional materials provided. It is important for an educator to begin the learning process and make it interesting and effective in order to grab the students' attention. The arrangement in the gamification quiz applications draws the students' attention to explore more deeply as their curiosity is stimulated through the topics contained in the gamification quiz applications. While for non-gamification quiz application, the students' stimulation is focused on the use of text and graphics to differentiate each of the programs provided. The differences in colour helped the students to better understand the concept of the program due to the delivery method. Both applications have the interesting features that help the students to utilize them.

2) Relevance influences students' motivation and associates their existing knowledge with the new knowledge in the instructional materials. It also helps students to understand and apply their knowledge and skills in the future. The layout in the gamification applications was easy to understand as it is in accordance with the course syllabus and students were guided with the topic contained in the gamification application. The students also were facilitated by the reference materials. Whereas for non-gamification quiz application, the learning objectives were explained by the lecturers and learning reference materials provided referred to the non-gamification quiz application.

3) Confidence emphasizes the positive values and students' motivation with regard to the assigned activity or task. A meaningful experience helps to enhance student's confidence during the teaching and learning process. The gamification quiz application was arranged according to the topic section as in the syllabus notes and this structure helps to facilitate students in using the gamification application. This division of sections has given the students confidence and create positive expectations for them to succeed. Students' high understanding will motivate them to be self-confident. As for the non-gamification quiz application, the structure for the topic was according to the lecture week.

4) Students will gain satisfaction when they practiced their knowledge, skills and when they receive a good response to continue with their learning. The students will receive reinforcement to maintain their learning[16]. According to Keller and Burkman [17], the motivation for learning is to use motivation principles to encourage students to learn. In designing a teaching material, it should be systematically designed in order to integrate motivational principle that will encourage the students to learn. In the gamification quiz application, the quizzes were design to be randomly generated where the questions will be shuffled each time the students answer quiz questions. Students' satisfaction occurred when students can answer questions accurately and it helps them to improve their knowledge and skills in their learning. The scoring displayed in the gamification application also encouraged the students to proliferate their knowledge. This situation encouraged the students to be motivated in using the application provided.

Generally, all four components of ARCS model which are attention, relevance, confidence and satisfaction supported the application of the gamification quiz implemented in this study as well as the non-gamification quiz. The components and key basis in the ARCS model helped the educator in meeting the students' needs which closely related to their motivation especially their motivation to acquire new knowledge. Motivation is very important in the learning process because motivation can boost and inspire the students to receive information in the teaching and learning process [15].

Therefore, the focus of this study is to investigate the students' motivation towards the gamified learning and the comparison between the application of the gamification quiz and the non-gamification quiz application that can accessed through mobile devices which was mobile phones.

STATEMENT OF PROBLEM

Basic Programming is a course that has a high failure rate among students [18]. According to Wei-Meng [19], students were not familiar with programming development methods, algorithm (pseudo code and flowchart) algorithm and basic control structure for sequential control structures, optional control structures as well as the repetitive control structures. Studies have shown that student were not able to describe the process of programming and this includes the method of executing the programs that show the movement of rows starting from the first line to the last line [20]. Tan Phei Yee [20] further elaborated that the students also were not able to describe accurately the method of executing the programs such as in the 'for loop' programming part, as they will need to see how the 'for loop' programs is being executed when the execution requirements are met.

Effective learning activities will help the students to change their motivation towards the Basic Programming course [20]. The concept of pair programming should help the students to create better programming and it was more fun to learn in a pair than the students who did it independently [21], [22]. Therefore, the gamification approach in this study is to serve as a platform and a tool for the educators in assisting and supporting the students to overcome this issue and increases their motivation in learning this course.

RESEARCH OBJECTIVE

The following is the objective posed for this study:

To investigate students' motivation toward gamification quiz application and non-gamification quiz application in the Basic Programming course.

RESEARCH HYPOTHESIS

This study, therefore, hypothesized that:

H01: There is no significant difference in students' motivation after applying the gamification quiz and non-gamification quiz for the Basic Programming course.

METHODOLOGY

This study used quasi-experiments research design in order to investigate students' motivational variable. The sample of this study was divided into two groups which were tested in a simulated way to assess students' motivation with regard to the use of gamification quiz application and the non-gamification quiz application. Both applications of gamification and non-gamification quizzes were accessible through a smartphone or tablet.

POPULATION AND SAMPLE

The population in this study consists of 80 students of Diploma in Digital Technology (DDT) from the Department of Information and Communication Technology, Seberang Perai Polytechnic. The sample of the study consists of 60 people based on convenience sampling. Convenience sampling according to Creswell [23] is where the researchers select respondents based on their availability for research. Students' selection for both groups is equally parallel to the aspect of students' enrollment into the polytechnic.

RESEARCH INSTRUMENT

The questionnaire in this study consists of two parts, Part A and Part B. Part A is about the respondents' demographic data aimed to obtain information regarding gender as well as age in order to acquire the number of male and female respondents for polytechnic students.

Part B in this questionnaire focused on students' motivation while using the Learn C ++ and the non-gamification quiz application. 32 questions were adapted from the Instructional Materials Motivation Motivational Survey (IMMS) by Keller [15] which has been translated by Toh Seong Chong from the Center for Teaching And Multimedia, Universiti Sains Malaysia into the Malaysian language question. The scale on the motivation instrument was measured based on 5 level Likert scale which was; 1: Strongly Disagree, 2: Disagree, 3: Not Sure, 4: Agree and the 5th: Strongly Agree.

PILOT TEST

A pilot test has been conducted to investigate whether the questionnaire was reliable to generate accurate results before implementing the actual survey. A Pilot test is important in order to obtain feedback from students about the applications being used. In this study, a pilot test was carried out on research instruments to examine students' motivation after using both quiz applications. A total number of ten sets of questionnaire were collected from the students who did not participate in the real study.

RELIABILITY

To test the reliability of this research instrument, the Cronbach's Alpha Coefficient was used.

Table 1:
Reliability Test

Variable	Number of Items	Cronbach Alpha
Motivation	32	0.959

Table 1 refers to the value of the resolution of Cronbach's Alpha for motivational instruments. The IBM SPSS version 17 has been used in to test the questionnaire. The findings from the reliability test on the questionnaire that were outline found that the Cronbach's alpha value for all factors exceeded 0.7 (> 0.7), which means that each factor is good and reliable. Thus this questionnaire exceeded the minimum requirement of Cronbach's alpha which is 0.7, it commonly accepted by most of the researchers to indicate this variable is reliable [24] and can be continued with the following analysis.

RESEARCH PROCEDURE

In this study, the duration of the experiment is for three weeks. During the course of the study, the educator tought both group the same topic to ensure that the time allocated is in accordance with the designated plan. After the learning process was concluded, one group was given Learn C ++, as their gamification quiz application another group was tested using non-gamification quiz application. The questionnaire was distributed to the students after both groups from the experimental group and the control group received the treatment. The purpose of the questionnaire was to assess the students' motivation for both groups after receiving the treatment given through the non-gamification quiz application and the Learn C ++ App through the google form.

RESULT

The results from this study includes descriptive and inference analysis. For descriptive statistics, in order to describe demographic data and research instruments, the percentage method was used. As for inferential statistical analysis, it was used to test the hypothesis of the study using independent sample t-test. The data was analyzed using the IBM Statistical Package for the Social Science version 23.

Demographic Data

A total of 60 students from Diploma in Digital Technology were involved in the study. The researcher received 94.64% responses through the google form. This amount exceeds the figure set by Kerlinger [25] which is 80%.

Table 2
Age of the Respondents

	DDT A	DDT B	
Age	No (%)	No (%)	Total
18-20	17 (57)	15 (50)	32
21-24	12 (40)	14 (47)	26
25-30	1 (3)	1 (3)	2
Total	30 (100)	30 (100)	60

Table 2 shows the respondents' age for both groups. For DDT A, 57% of the respondents were between the ages of 18 to 20 years. A total of 40% make up for the age between 21 until 24 years old, followed by only 3% respondent between the age of 25 years to 30 years. As for DDT B, the number of respondents between 18 and 20 years was 50%. For the age of 21 years to 24 years, it comprises of 47%, followed by 3% respondent between the ages of 25 years to 30 years.

Table 3
Gender of the Respondents

	DDT A	DDT B	
Gender	No (%)	No (%)	Total
Male	14 (47)	16 (53)	30
Female	16 (53)	14 (47)	30
Total	30 (100)	30 (100)	60

Based on Table 3, out of of the total of 30 respondents from DD A, 47% were male respondents whereas female respondents were more than male representing 53%. As for DDT B, the male respondents of DDT B were more than the female with 53% while female respondents were only 47%. This finding shows that the number of respondents involved is 60 persons for both classes.

Hypothesis Testing

H01 predicted that there is no significant difference in students' motivation after applying the gamification quiz and non-gamification quiz for the Basic Programming course. The Inference analysis involved t-test to investigate the differences in students' motivation after applying the gamification quiz and non-gamification quiz. The results of the Inference analysis as in the following Table 4:

Table 4
T-test Result on Student Motivation

Group	No.	Min	SD	t-value	*p-value*
Non-gamification quiz app	30	2.10	0.393	-14.924	0.001
Learn C ++	30	3.12	0.143		

Level of significants *p-value < 0.05*

Table 4 shows the mean value of motivation for the group of non-gamification quiz application which was 2.10, while the min for the gamification quiz application shows an increase of 3.12. For the standard deviation value of the non-gamification quiz, it shows the value of 0.393 while for the gamification quiz application, the value is 0.143.

The result of the analysis shows that the p-value for the value of t is 0.001 which is smaller than the significant level of $\alpha = .05$. This result shows that there is a significant difference in students' motivation after applying the gamification quiz and non-gamification quiz for the Basic Programming course. In conclusion, the null hypothesis stated is rejected.

DISCUSSION

The results from the Instructional Materials Motivation Survey (IMMS) suggest that the four main components of the ARCS Model namely attention, relevant, confidence and satisfaction were successfully applied in this study where the results from the analysis evidently showed that there were differences in students' motivation between the control group and the experimental group. This shows that the application of gamification quiz, Learn C ++ has a positive impact on student motivation in the experimental group. The application of gamification clearly increases the students' motivation and in addition, it also improves their performances and their focus on learning.

Based on the result it indicates that the requirement for the first component which is attention was fulfilled where gamification quiz application, Learn C ++ captures the students' attention and their interest. The arrangement in the application managed to draw their attention and curiosity to explore and learn. As for the second components, relevant refers to the students' understanding on gamification application which was similar to the course syllabus. The third component that increases the students' motivation toward gamification is confidence which refers to the learning materials and their existing knowledge has given confidence to

students during the course of teaching and learning. Lastly is satisfaction which means reinforcing the students' accomplishment when they receive good responses after they successfully answer the quiz.

The finding of this study shows that the students' motivation was high when they used gamification quiz application, Learn C ++, compared to the non-gamification quiz. This finding is consistent with the findings of Su [26], Buckley & Doyle [10], Khaleel, Ashaari, Siti et al.[27] which provides positive feedback on the use of gamification and it also enhances students' motivation.

Gamification associates with technology and while applying this approach, it requires skills to utilize today's technology. Thus, gamification should be applied to nowadays generation students as an innovative teaching tool [7] in order to facilitate the learning process and improve their motivation [28][29]. Respondent's acceptance of mobile technology due to the strong perception and understanding of the concept that the role of gamification is important in today's learning. The finding is in line with previous studies which conclude that gamification improves the teaching quality and student's potential on learning [1], [9], [10], [11].

CONCLUSION

In summary, this study concludes that gamification has a positive impact, particularly on the students' motivation. It evidently suggests that the effect of gamification on students' motivation is high and it also enhances students' understanding. Therefore, this gamified learning approaches influence students' motivation during the learning process as it provides an encouragement and enjoyment for the students to learn independently in order to improve their knowledge. Applying gamification in an educational setting could benefit the students as well as the educator as it can be very effective and it can create a meaningful learning experience for them.

Future research should explore more on the implementation of gamification in a classroom with a longer duration by focusing on the application of specific game elements and investigate its effectiveness.

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