

Analysis of Gamification Implementation on Student Motivation and Learning Outcomes**Rifa'atul Mahmudah Burhan¹, Jamilatul Badriyah²**rifaamb@iteba.ac.id¹, milabadriyah7@gmail.com²¹Institut Teknologi Batam²Universitas Madura

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Abstract

This study aims to analyze the effect of applying gamification methods on student motivation and learning outcomes in computer architecture and organization courses. The study was conducted using a quantitative approach with an experimental design to obtain valid data. Based on the research conducted, it can be concluded that the application of gamification methods has a significant positive impact on student motivation and understanding. Specifically, the use of gamification increased the average motivation score by 27.3, compared to an increase of 6.1 in conditions without gamification. Similarly, the aspect of understanding experienced an average increase of 27.1 with the application of gamification, while without gamification it only reached 5.4. In general, the results of this study indicate that the use of gamification in the learning process has a greater impact on increasing student motivation and understanding compared to conventional learning methods without gamification.

A. Introduction

Computer Architecture and Organization is one of the fundamental courses in information technology and software engineering education[1]. This material plays an important role in equipping students with a deep understanding of the internal structure of computers, computer system design, and the integrated working mechanisms of hardware and software[2]. However, in practice, the learning process for this course faces a number of significant challenges. First, the complex and abstract nature of the material is a major obstacle to student understanding[3]. Concepts such as processor architecture, memory management, and internal data paths tend to be theoretical and require a deep understanding of the basic principles of computer technology[4]. The high level of difficulty of this material often causes students to lose interest, resulting in suboptimal learning motivation. The lack of practical approaches and interesting visualizations in the learning process can worsen students' perception of computer architecture and organization as a difficult and boring course. With the times, the current student learning model emphasizes the use of digital technology and interactive learning methods[5].

Learning for students today faces various challenges and dynamics influenced by technological developments, social changes, and industrial needs. Generation Z students have a mindset and learning style that is very different from previous generations, where information and communication technology has become a vital part of everyday life [6]. This is also known as *digital natives*, who have characteristics such as high dependence on technology and digital media[7], a preference for multimedia and visual learning, expectations of instant *feedback*, responsive learning, and multitasking abilities but with a short *attention span* [8]. Today's students tend to be more interested and motivated when the learning process is packaged in an attractive and relevant way to the digital world, such as through the use of audiovisual media, simulations, and interactive technology-based learning [9].

Amidst these conditions, gamification has emerged as an innovative approach that can increase student engagement and motivation to learn[10]. Gamification, which is the application of game principles in a learning context, can help convey complex material in a more fun and interesting way, as well as encourage active student participation in the learning process[10][11]. As a result, these challenges have an impact on the academic success and interest of students in the fields of computer architecture and organization. Therefore, an in-depth analysis of the application of gamification in the teaching of Computer Architecture and Organization courses is needed to determine the extent to which this method can be an effective solution in increasing student motivation and understanding. Thus, it is hoped that the results of this study can make a real contribution to the development of more interesting and meaningful learning innovations.

B. Research Method

This study was conducted through a series of systematic stages to ensure the validity and reliability of the results obtained. A quantitative approach with an experimental design was used in this study to obtain valid and reliable data. The stages of the research framework can be seen in Figure 1.

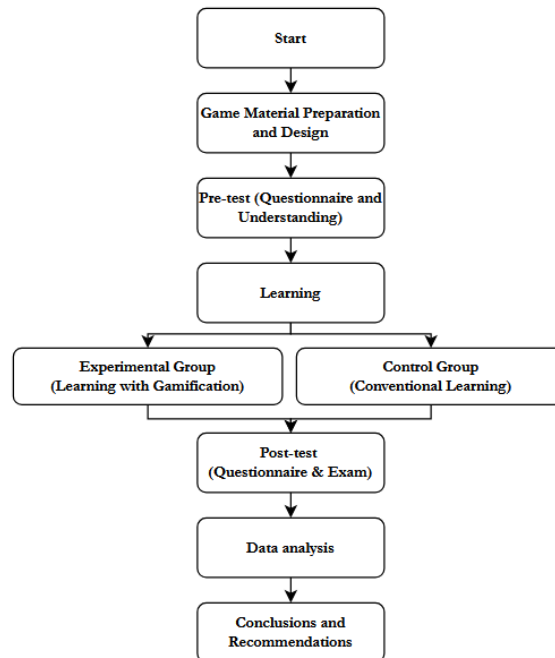


Figure 1. Research Stages

The main instruments used were questionnaires developed based on relevant theoretical frameworks and gamification software specifically designed to increase participant engagement. These instruments underwent validation and reliability testing before being used in data collection. For a clearer picture of the instrument stages, see **Table 1** below:

Table 1. Instrument Stages

Stages	Activity	Desc	Time
1	Game Material Preparation and Design	Curriculum development, educational game design, faculty training	2 weeks
2	Pre-test	Students filled out a questionnaire on motivation and initial understanding.	1 day
3	Pembelajaran	- The experimental group followed a learning process packaged in the form of educational games, such as interactive quizzes, points, badges, and leaderboards. - The control group followed conventional learning without gamification elements.	4 weeks
4	Post-test	Students fill out questionnaires and take final exams	1 day
5	Data Analysis	Quantitative data were analyzed using statistical tests such as t-tests to determine significant differences between the two groups. Descriptive analysis was used to describe the level of motivation and understanding of students.	2 weeks
6	Conclusion	providing conclusions from the research results	3 day

1. Data Collection

This study adopted a quantitative approach with an experimental design to analyze the effectiveness of gamification methods in the learning process through the use of interactive media. Quantitative data was collected through questionnaires that measured motivation, engagement, and conceptual understanding, as well as data on participants' scores and achievements.

a) Population and Sample

Participants were divided into experimental and control groups, where the experimental group actively used interactive media during the learning process and the control group followed conventional learning.

b) Research Instruments

The main instruments used were observation sheets, questionnaires, and activity data from the interactive media platform. These instruments underwent content and reliability validation to ensure accuracy and consistency in data collection. Data collection was carried out through the application of a gamification-based learning model that integrated Kahoot and Quizizz as the main media in the learning process.

2. Data Analysis Techniques

Data analysis was performed using descriptive statistics to describe the characteristics of the respondents and their level of participation. Next, hypothesis testing was conducted through inferential analysis to determine the significant effect of the use of gamification media on the learning outcomes of the participants. In addition, analysis of data from the interactive platform was also conducted to measure the level of engagement and effectiveness of the media in increasing the participants' motivation to learn.

a) Research Data Structure

The data in this study was collected from 20 students enrolled in the computer architecture and organization course, who were coded R1 to R20. The learning methods used were divided into two groups, each consisting of 10 students. The first group, which used a gamification approach, consisted of respondents R1 to R10. Meanwhile, the second group, which did not use gamification (conventional learning method), consisted of respondents R11 to R20. This division aimed to compare the effect of the gamification method on respondents who participated in gamification-based learning with those who participated in the learning process without gamification.

b) Measured data

At the data collection stage, there were four main data points that served as benchmarks in the study. The four main data points can be seen in the following table:

Table 1. Measured data

Measured data	Function
Motivation Before and After	shows the level of motivation of participants before

Change in Motivation	and after participating in the learning method. difference between motivation after and before implementing the gamification method.
Understanding Before and After	participants' level of understanding before and after participating in the learning process.
Change in Understanding	difference between understanding after and before.

1) Motivation Before and After

At this stage, student motivation data is measured before and after participating in the learning process. Measurements are taken to determine the initial level of motivation of participants before the application of a particular method, as well as changes in motivation that occur after the learning process takes place. This data provides an overview of the influence of learning methods on student motivation.

2) Motivation Change

This stage involves analyzing the difference between motivation after learning and motivation before learning. In other words, this data shows the extent of increase or decrease in student motivation as a result of the learning method applied. Motivation change data is obtained from the difference between motivation scores after and before the learning method was applied. The formula is:

$$\text{Change Motivation} = \text{Motivation After} - \text{Motivation Before} \quad (1)$$

In this way, we obtain numerical values that indicate an increase or decrease in each participant's motivation after participating in the learning process using a particular method. If the change is positive, it means that the participant's motivation has increased, if it is negative it means that it has decreased.

3) Understanding Before and After

Comprehension measurements are conducted to assess students' mastery of the material before and after participating in the learning process. This data helps in assessing the effectiveness of learning methods in improving students' understanding of concepts or material. The methods used to measure comprehension are questionnaires and comprehension tests, in which respondents are given questions or statements that measure their level of understanding of certain material before and after the gamification learning method is applied.

4) Change in Understanding

This stage refers to the difference between the level of understanding after and before learning. This data shows the extent to which the learning process can improve students' understanding of the material being studied. Data on changes in understanding is obtained from the difference

between motivation scores after and before the learning method is applied. The formula is:

$$\text{Change Understanding} = \text{Understanding After} - \text{Understanding Before} \quad (2)$$

3. Gamification

Gamification is an innovative approach that integrates game elements such as points, badges, challenges, and leaderboards into technology-based learning processes[11]. The main objective of gamification is to increase student motivation and improve their learning outcomes through a more engaging, interactive, and enjoyable learning experience[12]. Gamification functions as a pedagogical strategy that utilizes game mechanisms and designs to mobilize students' active participation in the teaching and learning process. Thus, the use of gamification methods aims to create a learning environment that can motivate students intrinsically and extrinsically, as well as optimize their academic achievement through the application of technology that is in line with the characteristics of the current digital generation[13].

Kahoot and Quizziz are game-based interactive media platforms used to implement a gamification approach in the learning process[14]. Both platforms utilize dynamic and engaging quiz features, designed to increase student motivation and participation through game elements such as points, leaderboards, challenges, and completion times[15]. In practice, Kahoot and Quizziz are used as the main media for delivering learning materials, testing understanding, and conducting evaluations directly during the learning process[16]. Participants are invited to actively participate in interactive quizzes, where they can answer questions in real-time using digital devices such as laptops, tablets, and smartphones.

C. Result and Discussion

From the data collection stage involving 20 respondents who were students of the information systems study program, the values of the four main data to be measured were identified and obtained, including pre-motivation scores, post-motivation scores, motivation change scores, pre-understanding scores, post-understanding scores, and understanding change scores. The data results from the two research groups are presented in separate tables. The first group consists of students who were taught using the gamification method, while the second group consists of students who were taught conventionally, without using the gamification method. The raw data from group 1 can be seen in the following table.

Table 2. Respondent Data Using the Gamification Learning Method

No	Res p	Learning Methods	Motivation before (%)	Motivation after (%)	Change Motivation	Understanding Before (%)	Understanding after (%)	Change Understanding
1	R1	Gamification	50	80	+30	45	75	+30
2	R2	Gamification	55	85	+30	50	80	+30
3	R3	Gamification	60	78	+18	55	72	+17
4	R4	Gamification	52	83	+31	48	78	+30
5	R5	Gamification	58	86	+28	53	82	+29

6	R6	Gamification	49	75	+26	44	70	+26
7	R7	Gamification	54	80	+26	50	76	+26
8	R8	Gamification	55	81	+26	52	77	+25
9	R9	Gamification	53	79	+26	49	75	+26
10	R10	Gamification	50	82	+32	46	78	+32

Data for the second group, which consists of students who underwent conventional learning without the use of gamification methods, can be seen in the following table:

Table 3. Respondent Data Without Using Gamification Learning Methods

N o	Resp	Learning Methods	Motivati on before (%)	Motivati on after (%)	Change Motivatio n	Understand ing Before (%)	Understand ing after (%)	Change Understand ing
1	R11	Non gamification	55	60	+5	52	55	+3
2	R12	Non gamification	50	55	+5	48	52	+4
3	R13	Non gamification	52	58	+6	50	55	+5
4	R14	Non gamification	53	61	+8	49	57	+8
5	R15	Non gamification	54	63	+9	51	60	+9
6	R16	Non gamification	50	56	+6	47	53	+6
7	R17	Non gamification	49	55	+6	45	50	+5
8	R18	Non gamification	52	58	+6	49	55	+6
9	R19	Non gamification	55	60	+5	52	56	+4
10	R20	Non gamification	50	55	+5	48	52	+4

The table above shows the grouping of data to be tested based on analysis indicators. A comparison of pre-test motivation, post-test motivation, pre-test understanding, and post-test understanding for the research group is also presented in the form of graphs in Figures 2, 3, 4, and 5 below.

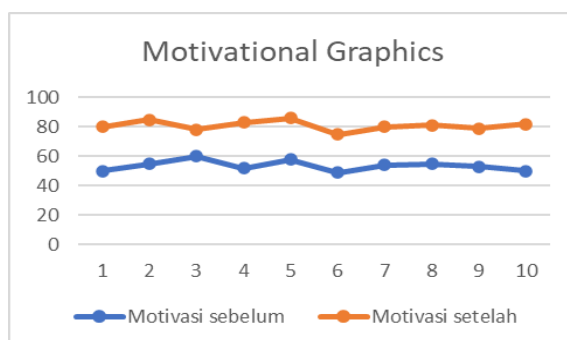


Figure 1. Motivational Graphics with Gamification Method

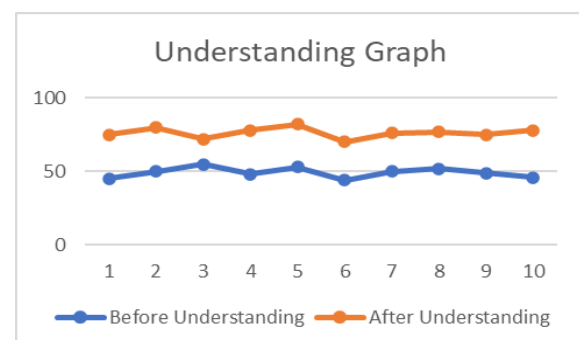


Figure 2. Understanding Graph without Gamification Method

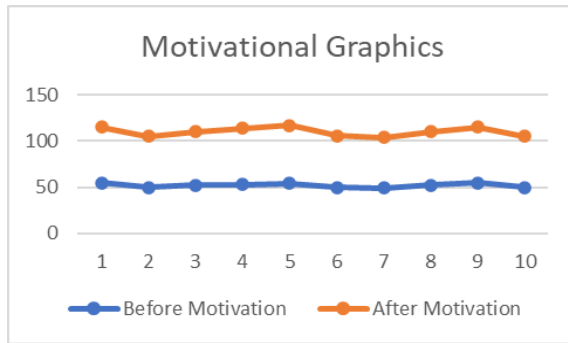


Figure 3. Motivational Graphics without gamification Method

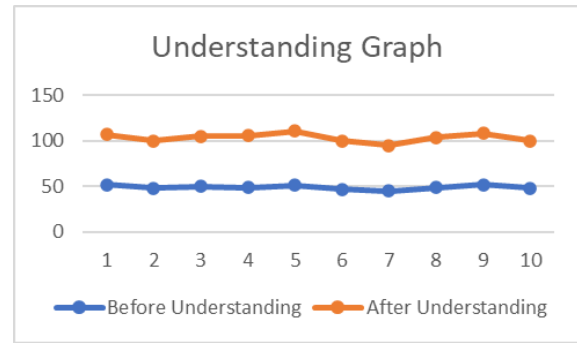


Figure 4. Understanding Graph without gamification Method

The image above shows four graphs comparing changes in student motivation and understanding before and after participating in the learning process, both with and without gamification methods.

The motivational graphics with gamification method shown in Figure 2 indicate that participants' motivation scores increased after gamification was applied. At each point (1 to 10), motivation scores after using gamification were consistently higher than before its application. This indicates that the gamification method is effective in increasing student motivation. In Figure 3, the understanding graph without the gamification method shows that participants' comprehension scores also increased after the learning process, although the increase was not as significant as in the motivation graph. The scores after understanding the material remained higher than before understanding, indicating an increase in participants' comprehension.

Figure 4 shows motivational graphics without gamification methods, indicating that participants' motivation before and after the learning process without gamification increased, but the difference was not as significant as in the graph with gamification. There was still an increase in motivation, but it was smaller than with the gamification method. Figure 5 shows understanding graphs without gamification methods, indicating that participants' understanding increased after the learning process without gamification, but the increase tended to be smaller than in the graph with gamification.

After the data was obtained, calculations were performed using statistical analysis to calculate and determine the values of increased motivation and changes in understanding. The purpose of this stage was to analyze the effect of the learning method using gamification compared to learning without gamification on student motivation and understanding. Statistical analysis was performed to obtain values for increased motivation and increased understanding between the two research groups. The data analysis process was as follows:

a. Average Increase in Motivation:

Gamification:

$$\frac{30 + 30 + 18 + 31 + 28 + 26 + 26 + 26 + 26 + 32}{10} = 27.3$$

Without gamification:

$$\frac{5 + 5 + 6 + 8 + 9 + 6 + 6 + 6 + 5 + 5}{10} = 6.1$$

- b. Average Improvement in Understanding:
Gamification:

$$\frac{30 + 30 + 17 + 30 + 29 + 26 + 26 + 25 + 26 + 32}{10} = 27.1$$

Without gamification:

$$\frac{3 + 4 + 5 + 8 + 9 + 6 + 5 + 6 + 4 + 4}{10} = 5.4$$

From the data analysis, an increase in motivation and understanding was observed in both research groups, as shown in the following table:

Table 4. Increased Motivation and Improved Understanding

Learning Methods	Average Increase in Motivation	Average Improvement in Understanding
gamification	27.3	27.1
without gamification	6.1	5.4

Based on the table presented, it can be concluded that the application of the gamification method shows an average increase in motivation of 27.3, while without the application of gamification shows an average increase of 6.1. This shows that the use of gamification can significantly increase student motivation. Furthermore, in terms of comprehension, the application of gamification resulted in an average increase of 27.1, which is higher than without gamification, which only reached 5.4. This data indicates that the gamification method also has a positive effect on increasing students' comprehension of the material being taught.

D. Conclusion

Based on the research conducted, it can be concluded that the application of gamification methods has a significant positive impact on student motivation and understanding. Specifically, the use of gamification increased the average motivation score by 27.3, compared to an increase of 6.1 in conditions without gamification. Similarly, comprehension scores increased by an average of 27.1 with the application of gamification, while without gamification, the increase was only 5.4. In general, the results of this study show that the use of gamification in the learning process has a greater impact on increasing student motivation and comprehension compared to conventional learning methods without gamification.

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