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# Implementation of the Gamification Concept in the Development of a Learning Management System to Improve Students' Cognitive In Basic Programming Subjects Towards a Smart Learning Environment

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**Abstract**

*Rapidly developing technology has produced many inventions that can help facilitate human life in various fields, one of which is the field of education that can help masters and students in the learning process, one of the technologies that help is the application of Learning Administration Framework in e-learning, where with this e-learning learning activities can be carried out flexibly by both masters and students. The role of motivation has an important position to achieve learning objectives, one of which is to improve cognition, therefore various ways are done to motivate students in the learning process. In this research, an effort is made in the form of implementing Gamification which is one of the learning approaches by bringing and applying elements of amusement elements into the Learning Administration Framework to increase student motivation and cognition in the learning process by using the ADDIE method, towards a Shrewd Learning Environment. Analysis of pre-test and post-test results using N-Gain calculations was carried out on both groups, where the results of the average N-Gain value of the gamification group amounted to 26.6111 and for the Non-LMS group amounted to - 19.8889. This explains that the gamification group has more cognitive improvement than the Non-LMS group.*

*Keywords: ADDIE, E-Learning, Learning Management System, Gamifikasi, Kognitif, Smart Learning Environment*

## 1. Introduction

Rapidly developing technology has produced many inventions that can help facilitate human life in various fields, one of which is the field of education which can help teachers and students in the learning process, one of the technologies that help is the application of the Learning Management System in e-learning, where with this e-learning learning activities can be carried out flexibly by both teachers and students.

Electronic learning or e-learning started in the 1970s[1]. E-learning is defined as any teaching and learning that uses electronic circuits to deliver learning content, interaction, or guidance[2]. In the use of e-learning, there is an application of technology to help support the learning system that has been used by many educational institutions, one of which is the Learning Management System[3].

In another research, Learning Management System is defined as an information technology system developed to manage and support the learning process[4]. Related to the application and use of Learning Management Systems in the field of education. Observations and interviews have been conducted with one of the teachers from a Vocational High School in the Lembang area, West Java. It seems that the use of Learning Management System at the school is rarely used for learning and has not been maximized when referring to the 3 functions that have been described, wherein the system both teachers and students can only upload and download assignments and then the assessment system is still done manually by the teacher. The few features of the e-Learning Management System cause students to be less motivated to learn using the Learning Management System that has been provided. Meanwhile, according to research conducted by Munoz, motivation has an important position in achieving predetermined learning objectives, learning can be interpreted as changes in individual behavior involving cognitive skills and attitudes to achieve educational goals[5].

The application of gamification in computer science learning in higher education has a positive impact such as increasing motivation and learning outcomes in student learning activities based on the results of research that has been conducted[6]. Basically, according to Ariani in her journal also explains that there are 2 types of gamification, namely structural gamification and content gamification[7]. In this research, the development will use structural gamification where game elements will be applied to the Learning Management System without changing the content, and the development of structural gamification is less complex when compared to content gamification, where content gamification requires storyline and good design skills of supporting elements in its development[8], [9], this is supported by a journal statement from (Ministry of Finance of the Republic of Indonesia learning center) mentioned that the design skills needed to create content gamification are greater than structural gamification[10].

In the literature, Smart Learning Environment (SLE) is a high-level Digital Learning Environment (DLE) that supports learner-centered, service-based, context-aware, personalized, interactive, and adaptive learning. In addition, SLE is also defined as a hybrid learning system (online, offline, and blended learning modes) that provides learners with an enjoyable learning process while achieving learning outcomes thanks to the use of smart tools and techniques[11]. This shows that the research conducted related to the development of a Learning Management System (LMS) aims to develop an intelligent and adaptive learning environment so that it can be adjusted to the needs and characteristics of each learner[12].

No research compares the difference in the use of the Learning Managthe ement System (LMS) with and without the application of gamification in increasing student motivation and cognitive in the learning process[13]. Therefore, this study can be a reference for future research to further explore the effectiveness of using LMS with the application of gamification in the learning process. There is no research that specifically discusses the contribution of using game elements in LMS in the development of Smart Learning Environment (SLE)[14]. This research contributes to integrating game elements into the LMS as a way to increase student motivation and cognition in the learning process. The contribution of this research is to provide empirical evidence that the implementation of gamification on LMS can improve students' motivation and cognition learning process[15]. The results also contribute to the development of Smart Learning a Environment (SLE) by showing how to integrate game elements into LMS as one of the ways to achieve fun and effective learning. This research also provides input for teachers and LMS developers in developing smarter and more adaptive learning technology[16].

Seeing this problem is certainly an opportunity to conduct research, development, and add features, one of which is the application of a gamification approach that will bring game elements into the Learning Management System using the ADDIE model towards a Smart Learning Environment.

## 2. Research Method

### 2.1 Development Method

The method used in developing systems and teaching materials is the ADDIE model development method, as explained in the previous chapter in the ADDIE model there are 5 stages namely Analyze, Design, Development, Implementation, and Evaluation[17]. Based on Figure 1, it can be seen that the research stages are as follows:

1) The analysis stage is carried out to identify and describe the needs required in the research. The analysis stage consists of an Analysis of Testing Instrument Preparation, System Non-Functional Analysis, System Functional Analysis, and Gamification Analysis.
2) The Design stage is carried out to identify and discuss application needs including creating use case diagrams along with tables to determine functionality based on user roles obtained from the results of system functional analysis[18], building the flow of the system to be implemented using Flowchart, creating Entity Relationship Diagrams making the design of gamification elements needed, building interface design and implementation of application interfaces.
3) The Development stage is carried out to create applications along with the needs obtained from the Non-functional system analysis stage[19]. The output results at this stage are applications with basic system functionality without the concept of gamification and styling.
4) The Implementation stage is carried out to describe the implementation process of gamification and styling elements in the design of the application system interface that has been built, where elements and elements of gamification such as points, levels, leaderboards, avatars, badges will be applied based on the results of gamification analysis.
5) The Evaluation stage is carried out to determine the success and suitability of the application by testing the functional system using the black box method, the definition of black box testing according to Vanduhe et al[20], which is quoted from a journal written by Castor et al Black box testing is software quality testing that focuses on software functionality that aims to find incorrect functions, interface errors, errors in the data structure, performance errors, initialization and termination errors[21]. After testing using the black box method, if the results of the test are successful, the application will be hosted to facilitate access when testing students in the learning process. In addition[22], this stage is carried out to test and analyze the effect of the Learning Management System with the implementation of gamification on increasing student motivation and cognition.

### 2.2 Population and Sample

The research location was carried out at SMK Binawisata Lembang, West Java. The population chosen in this study were students majoring in Software Engineering (RPL) at SMK Binawisata Lembang where the department was by the research to be carried out. The sample in this study was class X RPL 1 majoring in RPL SMK Binawisata Lembang which consisted of 30 people, which would be divided for the LIT test. people, which will be divided for the gamification LMS test as many as 15 people, and the Non-LMS test as many as 15 people.

### 2.3 Research Instrument

The instruments used in this study are Field study instruments in the form of questionnaires and interviews, Question instruments in the form of a collection of multiple choice questions, and student response instruments in the form of questionnaires with Likert scale options regarding student responses to the most interesting and preferred game elements in popular games, the most influential gamification elements[23], and the effect of increasing

learning motivation using the Learning Management System with gamification implementation[24].

## 3. Findings

3.1 Analysis

The analysis stage (analysis) is carried out to discuss 4 parts of the system requirements analysis to break down the information system into its parts including Testing Instrument Analysis, System Non-Functional Analysis, System Functional Analysis, and Gamification needs analysis which will be explained in the following sub-chapters:

1) Testing Instrument Analysis is carried out to compile instruments used for testing, based on the results of interviews conducted with RPL teachers, subjects that are difficult for students to understand are Basic Programming subjects. Before being used for testing, the instrument is submitted to experts with basic programming subjects for feasibility and validity testing.
2) Non-functional Analysis of the System is carried out to discuss software analysis (Software) which aims to be a supporting tool to assist in developing the system, the following is the software used using IDE software visual Studio code version 1.68.1, React.js version 18.1.0, Express.js 4.18.0, and for databases using PostgreSQL.
3) System Functional Analysis is carried out to discuss the explanation of the processes provided by the system based on user roles, the following is an explanation of the results of the functional analysis of the system: Admin has access to create teacher user accounts and access to delete teacher and student user accounts, Teachers have access to create courses, access to create materials and exercise questions, and access to create accounts for students, Students have access to join and access courses, have access to do exercises and read materials that have been created by the teacher.
4) Gamification Needs Analysis is a discussion of the results of literature studies and observations obtained from the results of questionnaire questionnaires which can be explained as follows:

| **Criteria** | ***Games*** | | |
|---|---|---|---|
| | **PUBG** | **Mobile Legends** | **COD: Mobile** |
| ***Creator*** | 57,9% | 78,9% | 42,1% |
| ***Leaderbord*** | 73,3% | 78,9% | 78,9% |
| ***Point*** | 47,4% | 38,8% | 31,5% |
| ***Badges*** | 38,8% | 52,6% | 68,4% |
| ***Rank/Level*** | 68,4% | 78,9% | 84,2% |
| ***Weapons/Gear*** | 84,2% | 73,7% | 84,2% |
| ***Maps*** | 38,8% | 10,5% | 26,3% |
| ***Dropboxes*** | 68,4% | - | 36,8% |
| **Tidak AdaJawaban** | 15,8% | 15,8% | 15,8% |

Table 1. *Comparison of Game Elements*

From Table 1 above, Leaderboard and Level elements are gamification elements that are consistently selected by students, this explains that of the three games, the Leaderboard and Level elements are the gamification elements in the game that are most liked and motivate students to play the game. Based on the three figures, students' choices are less consistent in other gamification elements such as Characters / Avatars, Exp / Points, and Badges, these gamification elements also tend to be rarely chosen by students several game elements are chosen by students but are not gamification elements, namely Weapon / Gear, Skin, Dropoxes, Skills / Ulti.

### 3.3 Design

The following is a Use Case Diagram design made based on the results of the analysis of system functional requirements to show the general user activity process in the Learning Management System, in Figure 1.

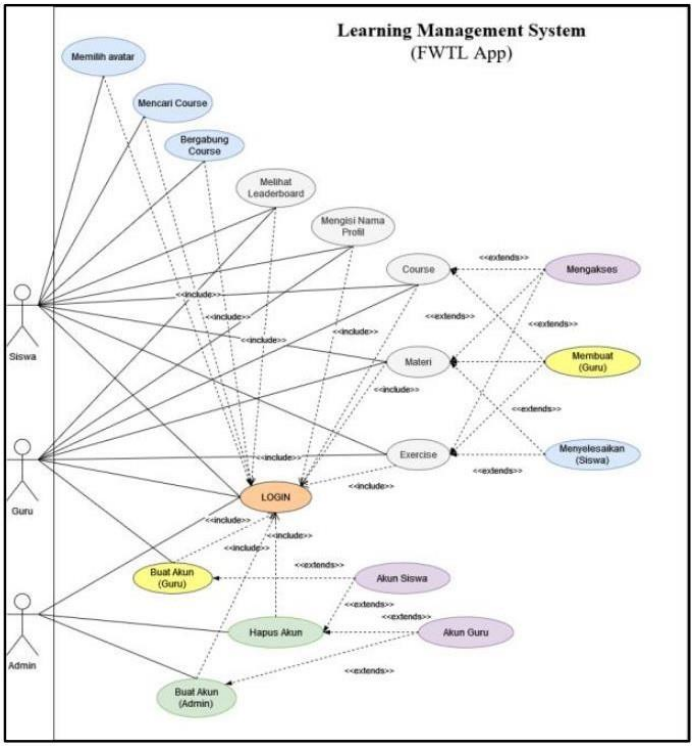


Figure 1. *Use Case Diagram LMS*

The following is a picture of the Entity Relationship Diagram (ERD) that builds data storage in the Learning Management System, the attached ERD is made of 12 tables, shown in Figure 2.

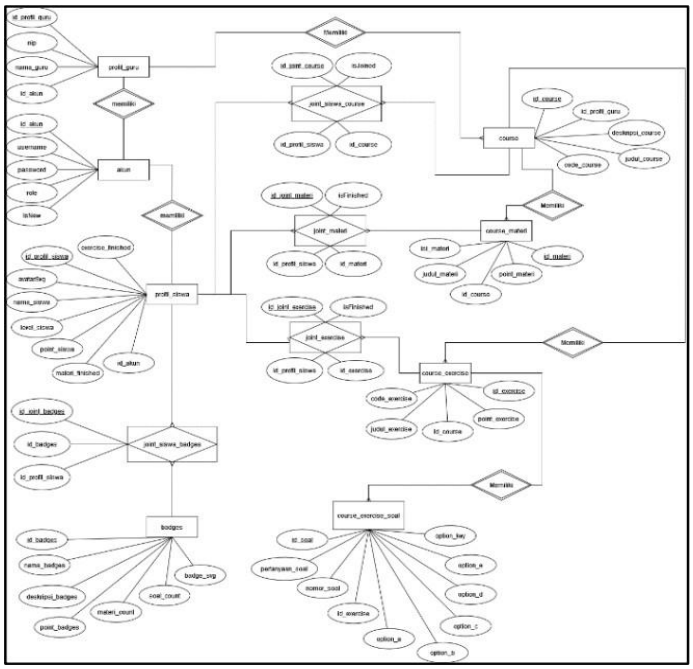

Figure 2. *Entity Relationship Diagram Design*

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Next are the design drawings of the two gamification elements, namely Avatars and Badges which are needed as assets to be implemented in the Learning Management System, shown in Figures 3 and 4.

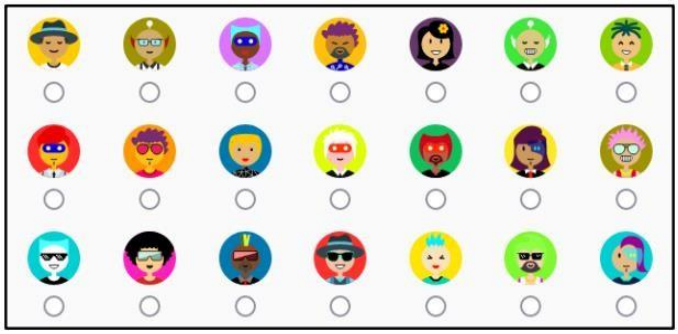

Figure 3. *Desain Elemen Avatar*


Figure 4*. Desain Elemen Badges*

### 3.3 Implementation

At this stage the display of the implementation of the gamification concept and the styling applied to the Learning Management System application will be attached, shown in Figures 5, 6, and 7. An overview of the system being developed uses the Gamification concept which brings and applies game elements to the Learning Management System, to increase motivation and cognitive cognition Figure 5 shows the student dashboard page that displays student personal profile data, from the number of courses attended, subject matter completed, number of student practice questions attended, number of badges, and levels achieved and points earned. Figure 6 shows the practice questions followed by students with scenarios students have completed material related to the subjects that have been taken and completed. Practice questions can be repeated a maximum of 3 times if students have not passed the exercise, and the questions are randomized by displaying other new questions. Figure 7, shows the achievements of students who have completed the exercise, the material from the lesson, and become the leading leader contained in the leaderboard menu, displaying the student's name, sequence, and level that has been achieved.

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*Figure 5. Implementation of Student Dashboard Pages*

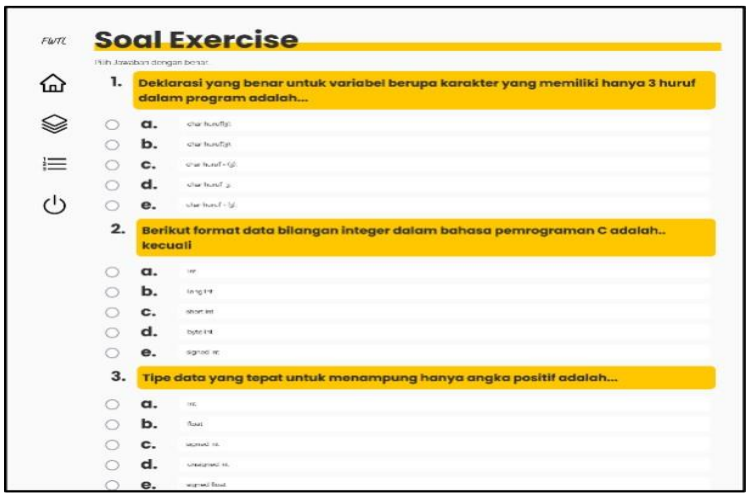


Figure 6. *Implementation of Exercise Question Pages*


Figure 7. *Implementation of Leaderboards Pages*

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**4. Evaluation**

In this stage, we will discuss the results of the questionnaire from testing the effect of the Learning Management System on increasing student motivation, the most influential elements of gamification, and the results of the pre-test / post-test to determine cognitive improvement. The following is each table from the results of the questionnaire analysis which contains 5 statements, table 2 is the result of the analysis of the LMS questionnaire without gamification, then table 3 is the result of the analysis of the LMS questionnaire with gamification, the analysis method used is interval analysis so that data can be calculated sequentially quantitatively by looking for the index of each statement [19], [20].

| Skor | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| **5** | 0 | 0 | 0 | 0 | 0 |
| **4** | 24 | 16 | 12 | 12 | 32 |
| **3** | 21 | 30 | 30 | 30 | 21 |
| **2** | 4 | 2 | 4 | 4 | 0 |
| **1** | 0 | 0 | 0 | 0 | 0 |
| **Total** | 49 | 48 | 46 | 46 | 53 |
| **Indeks** | 63,5 % | 64% | 61% | 61% | 70,6% |

Table 2. *Index Calculation Results*

| Skor | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| **5** | 30 | 25 | 55 | 25 | 20 |
| **4** | 28 | 36 | 16 | 32 | 44 |
| **3** | 0 | 3 | 0 | 6 | 0 |
| **2** | 0 | 0 | 0 | 0 | 0 |
| **1** | 0 | 0 | 0 | 0 | 0 |
| **Total** | 58 | 64 | 71 | 63 | 64 |
| **Indeks** | 77,3 % | 85,3% | 94,6% | 84% | 85,3% |

Table 3. *LMS Index Calculation Results with Gamification*

Based on Table 3 above, comparisons and explanations are made between the results of interval analysis based on index values to know the effect of gamification implementation in the Learning Management System learning media on increasing student motivation.

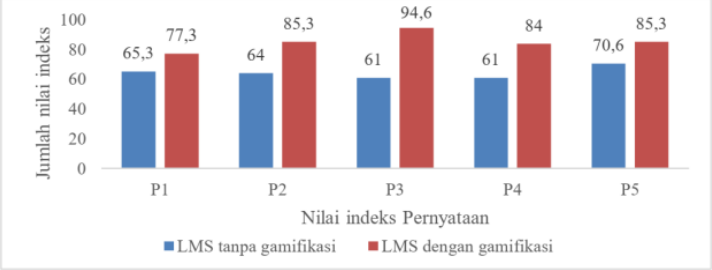


*Figure 8. Index Comparison Chart for Each Statement*

Based on the comparison of the index values of the 2 questionnaires in Figure 11, it can be explained that for each statement, the index value on the LMS with gamification is greater than the LMS without gamification, this means that students prefer to learn to use the LMS with gamification. Next will be a discussion and analysis of the results of the questionnaire regarding gamification elements, the purpose of this discussion and analysis is to identify the gamification

elements that have the most influence on the learning process on student motivation, along with the discussion:

| Skor | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| **5** | 55 | 30 | 55 | 10 | 30 |
| **4** | 16 | 36 | 12 | 44 | 36 |
| **3** | 0 | 3 | 3 | 6 | 0 |
| **2** | 0 | 0 | 0 | 0 | 0 |
| **1** | 0 | 0 | 0 | 0 | 0 |
| **Total** | 71 | 66 | 70 | 60 | 66 |
| **Indeks** | 94,6 % | 88% | 93,3% | 80% | 88% |

Table 4. *Calculation Results of Gamification Elements Questionnaire Index*

Description of the elements in each statement:
P1 = Avatar, P2 = Points, P3 = Leaderboards, P4 = Levels, P5 = Badges

Calculation of each statement to get the index value in Table 4 above shows that the Avatar (P1) element has the largest index value compared to other gamification elements of 94.6% which is in the interval value range of 81-100% which means Very Strong, this shows that the Avatar element is the most motivating gamification element for students, where students will try to reach the top ranking because they want to show the Avatar element they have chosen[25]. This is different from the results of the gamification needs analysis, where the avatar element was not the highest in the initial survey of gamification needs elements because several other elements were not gamification elements that made the respondents more interested. Furthermore, the Leaderboards (P3) element with an index value of 93.3% is in the interval value range of 81-100% which means Very Strong, this is by the first statement where the Leaderboards element is also very influential in motivating students because students are motivated to get the top ranking. Then the Point element (P2) and the Badges element (P5) have the same index, which is 88%. And the Level element (P4) with an index of 80%.

After discussing the analysis of the questionnaire regarding the effect of gamification concepts and elements on motivation, the results of the research evaluation in the form of a pretest and posttest which have been carried out using the N-Gain calculation will be discussed. The following are the results of the N-Gain descriptive analysis in the two groups which were carried out using the SPSS application, as shown in Tables 5 and 6.

| Class | *Cases* | | | | | |
|---|---|---|---|---|---|---|
| | ***Valid*** | | ***Missing*** | | **Total** | |
| | **N** | **Percent** | **N** | **Percent** | **N** | **Percent** |
| ***Gamifikasi*** | 15 | 100% | 0 | 0% | 15 | 100% |
| Non - LMS | 15 | 100% | 0 | 0% | 15 | 100% |

Table 5. *Case Processing Summary Normal Total*

| Class | | Statistic | Std. Error |
|---|---|---|---|
| *Gamifikasi* | Mean | 0,266 | 0,116 |
| | Median | 0,333 | |
| | Std. Deviation | 0,452 | |
| | Minimum | -1,000 | |
| | Maximum | 1,000 | |

| | | | |
|---|---|---|---|
| *Non-LMS* | Mean | -0,198 | 0,154 |
| | Median | 0,000 | |
| | Std. Deviation | 0,597 | |
| | Minimum | -1,500 | |
| | Maximum | 0,600 | |

*Table 6. Descriptive Total Normal*

The average N-Gain value for the gamification group was 0.266 while for the Non-LMS group, it was -0.198. A comparison of the N-Gain values of the two groups explained that the gamification group had an increase compared to the Non-LMS group, this explained that cognitive improvement in the gamification group was more than the Non-LMS group.

## 5. Conclusion

Based on the results and discussion that has been explained previously, the following are some things that can be concluded: The results of the questionnaire analysis regarding the most preferred game elements to motivate students to play the game have been successfully used as references and material for consideration in designing and implementing gamification elements in the Learning Management System towards the Smart Learning Environment, then based on the results of a comparative analysis of the questionnaire regarding the effect of implementing gamification on increasing student motivation, it shows that students are more motivated to use the Learning Management System learning application with the implementation of gamification, this can be explained by an increase in the index compared to the 5 statements given. The results of testing the effect of gamification elements on student motivation in the learning process explain that the most influential gamification elements in applying the gamification concept to the Learning Management System are the Avatar elements with an index of 94.6%. Based on the results of the analysis of the N-Gain calculations on the pre-test and post-test scores carried out in both groups, the gamification group had more cognitive improvement than the Non-LMS group, then the average score for the gamification group was 0.266, and for the Non-LMS is -0.198, while several factors have been explained at the analysis stage that may affect the value when the test is carried out.

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