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Research Paper

Gamification for Studying Mathematics by E-Learning

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Abstract

The difficulties of studying mathematics in this digital age call for solutions that might boost student engagement and motivation. To make learning more dynamic and interesting, it is suggested that a gamification methodology that combines game simulation with gamification is applied. In order to enhance mathematics instruction using an online learning platform. A thorough grasp of the difficulties associated with studying mathematics. To complement the learning objectives for mathematics, the gamification design includes selecting question types, constructing game situations, and producing visual components. This research creates a gamification paradigm using the Quizizz gaming application. The research focuses on the case of IKPIA Perbanas Jakarta for mathematics courses, which has the primary objective of optimizing mathematical learning through the concept of gamification. The researcher used the Dick and Carey development model, which has 10 phases from requirement identification to assessment, to create this learning model. The implementation of the Quizizz application and the gamification approach in an online learning environment occurs at the development stage. Technical configuration, application testing, and modifications based on preliminary feedback are all part of the implementation process. The success of the gamification technique in raising students' motivation and comprehension of the mathematics content was then assessed. Researchers used this helpful gamification to determine suitable designs for delivering learning content. Gamification for mathematics education is also very practical. In education, gamification by Quizizz as an application for gamification only supports but cannot replace the position of teachers and books. Mathematical learning devices with gamification are effective because they have met the classification very well at 79.17% and 20.83%, respectively, at an accuracy rate of 95.83%. Research has limited problems related to being carried out only in the IKPIA Perbanas Jakarta environment, which has students in semester one who have the characteristics of technology generation with the application of gamification that is integrated into the e-learning of Perbanas. The value of this research is the use of gamification for students studying in higher education and integrated into the Learning Management System (LMS).

Keywords *Gamification, Learning Mathematics, Perbanas Institute*

INTRODUCTION

The use of technology at this time in universities is a must to support the learning process. Current students born in 2003 and above are very attached to technology; their daily lives cannot be separated from gadgets like smartphones, laptops, and tablets. Perbanas Jakarta Campus has long implemented a learning URL (https://elearningperbanas.id), which is technology-based. However, there are challenges in increasing student engagement on this e-learning platform. One way is to include what many members of Generation Z do today, which is play games. In games, elements of challenge, strategy, and rewards are very inherent and liked by this generation. Gamification is the use of game elements or elements in non-playing conditions to strengthen positive learning behaviour (Ma & Oikonomou, 2017).

In e-learning used today, the addition of game features is applied. In developing gamification models for learning mathematics, the delivery of material, strategies, and game scenarios must be appropriate. This gamification must also be able to meet the needs and efforts to improve student

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competence in learning mathematics. For this reason, the use is applied to mathematics learning in Perbanas e-learning.

Process of learning Mathematics, the elements of practice, and working on questions according to the principle of learning that need repetition to achieve competence in the course (Fan et al., 2015). Some applications that support this, such as P-proof, Mentimeter, Kahoot, and Quizizz, are games that support many exercises and the completion of math problems. Researchers consider that one of the game applications can provide practice questions, and this activity is part of the game. Quizizz also has an element of challenge in that it feels interactive by telling who is in the best order (5 best). This motivates students at the Perbanas Jakarta campus to study and, of course, is expected to improve their learning outcomes.

Some innovations in learning have approaches, such as gamification, project-based learning (PBL), collaborative learning, and hybrid learning as the chosen alternatives (Zeiner-Fink et al., 2022). Gamification is the process of integrating game elements into other contexts, such as learning, to improve motivation and learning possibilities (Becker, 2005). This study's main objectives include increasing students' motivation to learn mathematics, improving students' ability to understand and apply mathematical concepts, reducing the difficulties of the students in learning math, identifying the effectiveness of gamification in math learning, and providing recommendations and solutions to integrate gamification into mathematics learning in the Perbanas academic environment.

Gamification with Quiziiz is one option because it meets the criteria of the learning process given game elements but is not in playing conditions, in this case, in learning conditions. Because of its interactive nature, having challenges and rewards makes learning more fun. Gamification also makes the learning atmosphere fun. This is why researchers created a gamification model using the Quizizz game application and integrated game simulations into mathematics learning activities.

LITERATURE REVIEW
Gamification

Gamification used in the mathematics learning process provides positive results, namely increasing student learning outcomes (Chizary & Farhangi, 2017). Interactive games have supported students' understanding of mathematical material and created a fun atmosphere in the learning process. In addition, gamification can increase motivation and create a more interesting learning environment (McLaren et al., 2017). Diverse technology approaches and resources have been employed to cater to the distinct requirements of mature learners. Gamification is a relatively new technique that applies game principles and components to non-gaming situations. In order to create a methodical understanding of how gamification might be included in adult learning, this chapter examines the literature and provides an overview of gamification applications. Following an electronic search of publications published between 2009 and 2019, a thorough review of 23 studies was done. According to studies, gamification has mostly been applied in professional settings and health education. The primary constructs under investigation are knowledge acquisition, motivation, engagement, and satisfaction. Further research is required, even if the examined publications show encouraging outcomes when using gamification to support adult learning.

Quizizz

One IT-based learning medium is Quizizz, an application for creating interactive quiz games that can be used as learning media. Quizizz is the best alternative choice for use as a learning medium, available in mobile applications such as Android and app stores, and can be used as a website through a browser on a computer (Hidayat & Frienti, 2020). Quizizz is an application in the

form of interactive quizzes that are considered able to attract students because they replace the old way of quizzes that only involved paper and pen but in the form of questions made by someone on Quizizz.com to be done by others by entering a join code. Using learning media that can be accessed through e-learning with technology can positively impact student interest in learning. The features available in Quizizz can also make it easier for teachers to assign assignments and assessment processes that can be downloaded in Excel format.

Gamification with Quizizz

Gamification, which has five learning models, namely behaviour, cognitive, constructive, experimental, and social learning, is expected to support mathematics learning, especially mathematical logic. Gamification-based quizzes and practice questions meet the elements of behaviour by making students accustomed to knowing mathematical formulas; cognitive elements by training cognitive aspects with mathematical logic content; experimental elements by trying various kinds of questions; social learning by doing quizzes at the same time; and interaction and competition between students in the process. For this reason, researchers tried to create a learning development model based on educational games for learning in universities and research in discrete mathematics courses held at Perbanas Institute Jakarta.

RESEARCH METHOD

Research methods included the following steps: literature reviews, research design, data collection, implementation, analysis, and interpretation of results. The design of a mathematical learning model using gamification at the Perbanas Institute in this study is qualitative research conducted by conducting a comprehensive construction of the learning process. In this case, the material and design are delivered through student interaction activities in the form of games, namely quizzes that are guided so that students can understand the learning material. The methodology carried out is to create conceptual and procedural models. The conceptual model is given the concept of gamification to be carried out. Then, the right learning design is made, namely using a procedural model in the form of a series of stages in the learning development process. The model design will use the systematic design of the instruction model by Dick et al. (2014); this design starts with: 1) Development Planning, 2) Needs and Goals Analysis, 3) Conducting Instructional Analysis, 4) Learning Analysis and Context, 5) Formulating Performance Objectives, 6) developing Research Instruments, 7) Developing Instructional Strategies, 8) Developing and Selecting Instructional Materials, 9) Instructional Revision, 10) Design and conduct summative evaluations.
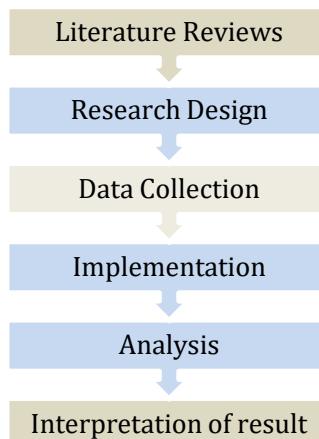

Figure 1. Research Method Gamification for Mathematics Education at Perbanas Institute

The research design of the learning model with gamification is part of step 7, which is to develop instructional strategies carried out in learning activities that are added to game activities in the form of quizzes both at the beginning and at the end of the meeting and making this gamification using the ADDIE model (Suratnu, 2023). Addie is an acronym for the five stages of a development process: Analysis, Design, Development, Implementation, and Evaluation.

Gamification phases include A) Analysis of user characteristics and analysis of content to be gamified; D) Prototyping of gamification and testing with users; I) Identification of rules in gamification and use by users; E) Measurement of the effectiveness of gamification in achieving learning goals.

Figure 2. The ADDIE Model

FINDINGS AND DISCUSSION

The design procedure is carried out using the modified Dick and Carey development model, which is a system-based development model combined with the Borg and Gall model in the first step of gathering learning information. The collection of information at the start of the study was carried out with the addition of preliminary research at the beginning and end of the Dick and Carey model; summary evaluation was not carried out because the process of summative evaluation requires a sufficiently high accommodation time to be implemented and replaced by a product production activity. As for the development of a mathematical learning model with gamification that online methods can access, learning models can be seen in the form of LMS as physical models and online learning media that are accessible by students wherever and whenever they have time.

In order to support the planning process and the accuracy of data and information, the planning is initiated through the activities of FGD. This activity is carried out to collect valid information related to the conditions occurring in the learning process and related devices, as well as to collect the learners' expectations regarding the expected learning process. This activity is also used to gather information related to the environment and the facilities given by the university to the lecturer in carrying out the teaching and learning process. Facts and data obtained from the results of FGD became the basis for the development of a mathematical learning model with gamification for students at Perbanas Institute.

Results of study accuracy analysis

The evaluation results through the questionnaire at the end of the field trial showed that the respondents agreed that the mathematical learning model with gamification can motivate students, with an average score of 4.25 on a scale of 1–5. These results reinforce the findings of the study, which suggest that learning mathematics with gamification improves student interest and motivation. In this study, the maximum score in the learning evaluation test is 100, and the minimum graduation limit is set at 70. To measure learning effectiveness, the percentage of student

learning accuracy of two test activities is used, i.e., accurately on the average of each meeting and accurately on the basis of the post-test results. The test results for each meeting (meetings 1-4) are calculated as averages and the students' accuracy, then presented in the following table. The experts involved in effectiveness analysis are learning experts and statisticians.

$$\text{Final Score Percentage (X)} = \frac{\text{Number of Graduated Students}}{\text{Number of Students}} \times 100\%$$

$$= \frac{23}{24} \times 100\%$$

$$= 95.83\%$$

Mathematical learning devices with gamification are effective because they have met the classification very well at 79.17% and 20.83%, respectively, at an accuracy rate of 95.83%.

CONCLUSIONS

Development of a learning model with game education for mathematical course logic capabilities using the Dick and Carey system design model in combination with the modified Borg and Gall model to enhance student learning outcomes through several stages, namely: gathering information and research, identification of aims, learning analysis, identifying student characteristics, writing learning objectives, development of criteria reference tests, learning strategies, development and selection of learning materials, as well as designing and implementing formative evaluation of instruction and revision of instructions. The research has limited problems related to being carried out only in the Perbanas Institute of Jakarta environment, i.e. early semester students born after 2010 have the characteristics of the generation of technicians with the application of gamification that is integrated into the e-learning of Perbanas. The design of a mathematics learning tool with gamification allows students to learn and practice in-depth, structured, and independently outside of face-to-face meetings in the classroom. The learning material is designed to be delivered and learned to the maximum extent outside factual classroom meetings. The importance of this study lies in the implementation of gamification for students in higher education and its integration into the Learning Management System (LMS).

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