The Influence of Game-based Learning Strategies and Game-based Learning on Mathematics Learning

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Abstract

This study aimed to compare the effect of game-based learning strategies and metaverse-based learning on mathematics learning. There are two learning strategies: game-based learning strategies as the control class and metaverse-based learning strategies as the experimental class. Learning independence is divided into high-learning-independence groups and low-learning-independence groups. This study used a quasi-experimental method with an Anova treatment design by level 2x2. The results showed that: (1) there was no significant difference in the learning outcomes of students who were taught using game-based learning strategies compared to metaverse-based learning g strategies. The research findings indicated that Game-based mathematics learning strategies can be implemented to support digital learning without an internet connection. At the same time, metaverse-based mathematics learning can be implemented to support learning using an internet connection.

Keywords: game, metaverse, mathematic, natural science learning

I. Introduction

Education plays an important role in improving quality human resources and requires innovation by educators in accordance with advances in science and technology without ignoring human values [1].This is seen as a means to produce intelligent, creative, skilled, responsible, productive and virtuous people. Various efforts have been made by the government in the field of education to innovate in the world of education. Innovation is usually carried out by taking into account three important reasons, namely efficiency, effectiveness and comfort. Efficient means that the time available for the teacher must be used as best as possible. Effective means that the lessons given must produce results that are beneficial to students or the community, while convenience

means a comfortable atmosphere, complete learning resources, learning aids and methods. As determined, the strategy is carried out in such a way as to provide enthusiasm and enthusiasm for students and teachers.

Natural Science is a collection of knowledge that is arranged systematically, and its use is generally limited to natural phenomena. The development of Natural Sciences is not only marked by a collection of facts, but also the emergence of the scientific method which is manifested through a series of scientific works, values and scientific attitudes. In line with this understanding, Mathematics is a series of concepts that are interrelated with concept graphs that have been developed as the results of experiments and observations, and will then be useful for further experiments and observations. [2]

Natural Sciences is a subject that must be given and studied at the junior high school level in Spain, starting from class VII to class IX. Natural Science is also one of the very important subjects

to be able to train and provide opportunities for critical and objective thinking to students. So that through the learning process of Natural Sciences, emphasizing the provision of direct experience to develop the competence of students in order to foster the ability to think, become scientific and understand the universe. [3]

From the scope of Mathematics subjects in grade 7, namely: digestive system, circulatory system, excretory system, and respiratory system. The scope of Mathematics subjects is one that is often complained about by students, especially in the matter of Mathematical formulas [4]. The difficulty experienced by students is that they have difficulty mastering the concepts of Mathematics. Natural Science is a difficult and varied and complex material, the problems found are caused because students tend to memorize important terms and examples in books only, so that if given problems that are different from those in books students will find it difficult to analyze.

The low learning of students in Natural Sciences subjects, this is due to the efforts made by teachers to improve Natural Sciences learning outcomes by students, has not worked as expected by using educational innovations. Educational innovation is a new and qualitative change that is different from the previous situation by deliberately trying to increase the ability to achieve maximum definite goals in education (Hanifa, 2017: 7). The shift in the learning paradigm from teacher-centered learning to student-centered learning requires the teacher's ability to innovate and be creative in designing the learning process that must be carried out.

Learning alternatives that are expected to improve students' abilities in limited conditions include choosing learning strategies that can improve student learning outcomes. Teachers must be able to consider other factors that can affect the learning process of students, both from internal and external factors. External factors of students include sight, hearing, posture, while external psychological factors include intelligence, skills, interests, attitudes, habits, motivation, self-concept, emotional and so on. The teacher does not only prepare learning tools such as syllabus, what is important is the best learning strategy in the learning process. In this case, teachers must continue to strive to improve pedagogical

abilities in addition to professional abilities, individual abilities and social abilities.

One of the characteristics of innovative learning for teachers is using technology in the learning process. Teachers are required to have the ability to use technology and apply it to the learning process. It has been proven that when studying at home, it has included Communication Information Technology into the learning process which can improve student learning outcomes and the quality of education. Two kinds of learning strategies are game-based learning and metaverse-based learning, as shown in Figure 1, and Figure 2. This study compares the effectiveness of learning using games and metaverse.

Figure 1 Game-based mathematic learning (ABQ Math Blog)

Figure 2 Metverse-based mathematic learning (Gorynvd | Dreamstime.com)

A. Game-based Learning

A game is an enjoyable activity pursued for pleasure, often without a specific purpose in mind. Any engaging and exciting endeavor can

be considered a game. Activities such as dancing, singing, playing musical instruments, and acting all fall under this broad definition of a game. While there are various interpretations of games, this book primarily categorizes games like Chess, Halma, Monopoly, Dominoes, Quizzes, and others. Games are characterized by having rules, forming a structured and often competitive or recreational experience [5].

Educational Games

Educational games, commonly known as "edugames," are designed to enhance the learning process, provide training, and enrich knowledge. The demand for educational games is notably high in many countries, even before children enter formal schooling. Early childhood learning games, in particular, are top-selling mobile educational games in numerous nations. Among the 33 game-based learning companies that secured funding in 2012-13, 23 focused on developing games for mobile platforms, with an impressive 20 concentrating on early childhood education [6].

Despite the potential of educational games, there are several drawbacks associated with existing options:

1. Limited Content: Many teachers do not utilize educational games because there is a scarcity of games that align with the specific material they intend to teach in their classes.
2. Lack of Educational Value: Existing learning games often lack true educational value. They typically present questions to students, and the students respond based on the computer's prompts, failing to engage students in meaningful learning experiences.
3. Preference for Videos: For simpler purposes, students often prefer accessing videos on platforms like YouTube, neglecting educational games. This preference is driven by the convenience of video content and the perception that videos are more engaging.

Educational games have immense potential in enriching learning experiences, but these challenges need to be addressed to fully realize their benefits in educational settings.

B. Mateverse-based Learning

Immersive experiences can make digital interactions feel more human. It supports the use of metaverse technologies such as virtual and augmented reality for specific use cases. Several kinds of VR applications in the form of entertainment or scientific purposes can be used as examples for various types of applications in the field of education.

The virtual world allows the merging of different digital learning content in various formats, such as video, text, images, web platforms, and more. It should suit teachers, adopt different positions in terms of management, and interact with emerging technologies.

Students in elementary school use many technology applications to college at various social and academic levels. Students use different tools through networking, text messaging, blogging, content sharing, online learning, and others. Students and teachers have used many computer applications and platforms in most aspects of their lives, especially Facebook, Wiki, YouTube, Instagram, LinkedIn, and Twitter [7].

The attention of experts, teachers, educators, and learning designers is influenced by the use of social media to enable them to use modern and intelligent audio-visual aids in the field of education. It is especially true in teaching methods in traditional and distance learning environments. A virtual classroom is an online learning environment that is not restrictive, affordable, flexible, practical, and accessible [8].

The virtual classroom platform helps make the learning experience interactive and engaging while providing a controlled environment. Virtual classrooms also offer features beyond the in-class experience, with instructors can access classes before lessons to prepare materials. These materials and session recordings are available after class for reference for instructors and participants. Participants can connect to the virtual classroom platform from any device that can connect to the Internet. This type of flexibility allows participants to get content, regardless of their worldwide location. A virtual classroom application designed for use on smartphones in conjunction with basic handheld VR headsets provided to students. The app is freely available for iOS and Android devices and can be found by searching for "Open Justice VR." [9]

Another significant benefit of virtual classroom software is that it facilitates tracking student progress. Instructors can consult data such as class attendance and student activity. In addition, they can track participant progress through online polls and analytics, identify areas of difficulty, and help participants learn subject matter with visual tools.

The use of the metaverse among higher education institutions led to the development of virtual campuses. A virtual campus is a digital space where students and teachers can talk, learn, plan and socialize. In addition, students on virtual campuses can take classes, hold meetings, attend conferences and job fairs, and even take campus tours as part of the college admissions process.

Many universities globally have started replicating their physical campuses with virtual campuses. For example, the Rady School of Management virtual campus at the University of California, San Diego (UCSD) allows students to participate in real-time virtual lectures and meet in break rooms and outdoor areas. Stanford University offers classes entirely in virtual reality settings that take students through virtual exploration and field trips. The Instituto Tecnológico de Monterrey, Latin America's leading university, hosts a virtual campus where students attend classes, interact with professors, and enjoy spaces to talk and socialize. [9]

Another virtual campus Laval Virtual World has excellent opportunities to broaden horizons and spark innovation with the kind of interactions that represent the future of education [10]. This campus has the following characteristics:
- The virtual campus is halfway between distance learning and the classroom experience. It combines the advantages of digital and physical pedagogical approaches by making them work with each other..
- The digital campus recreates the interaction and atmosphere of the actual campus, thus avoiding the feeling of isolation.

II. Research Method

The research was conducted in junior high schools because this research was adjusted to the class schedule at the school where the research was conducted so that it required digital class learning and had a good and smooth network class which was held from May 2022 to August 2022, 4 meetings were held during the study. In this learning strategy, students are required to actively communicate Mathematical ideas to friends and teachers

Based on the research objective, namely to examine the effect of the independent variable on the dependent variable, the method used in this research is an experimental research method. The research variables measured consisted of two main variables, namely: the dependent variable and the independent variable, with the following details:

1. The dependent variable

The dependent variable in this study is called the criterion variable. the criteria for the variables observed, namely the results of learning Mathematics

2. Independent variables

The independent variables in this study consist of behavioral variables and moderator variables, namely: a. Variable treatment, namely learning strategies consisting of game-based learning and mertaverse based learning, and b. The moderator variable is learning independence which consists of high learning independence and low learning independence.

III. Results and Discussion

1. Mathematics Learning Outcomes are taught using Game-based Learning Strategies

Test data for Mathematics learning outcomes of students who are taught using game-based learning strategies is the highest score is 97.50, the lowest score is 50.00, the average score is 79.50 and the standard deviation is 3.74 and the median is 17.28 The range of scores The empirical results obtained are 97.50-50.00 = 47.50, and the theoretical score is 0 to 100. The distribution of the frequency of students' Mathematics learning outcomes that are taught by game-based learning strategies.

2. Learning Outcomes Mathematics is taught using Metavese-based Learning Strategies

Test data for Mathematics learning outcomes of students who are taught using a metaverse-based learning strategy is the highest score

of 97.50, the lowest score is 50.00, the average score is 70.30 and the standard deviation is 3.64 and the median is 15.18 The range of scores The empirical obtained is 97.50-60.00 = 37.50, and the theoretical score is 0 to 100. The distribution of the frequency of students' Mathematics learning outcomes that are taught by metaverse-based learning strategies.

Based on the presentation of the research results above, the application of game-based learning, will affect the improvement of student learning outcomes which tend to have low learning independence because it can make it easier for students to be involved in the learning process. The game-based learning method is considered to have the potential to train students to think creatively when facing personal problems and group problems to be solved alone or together. In game-based learning, students learn independently to identify the causes of problems and solutions to these problems. Game-based is a learning process by providing cases or problems that must be solved by students. Thus, game-based learning is expected to improve student learning outcomes.

Based on the presentation of the research results above, the application of metavese-based learning, will affect the improvement of student learning outcomes which tend to have low learning independence because it can make it easier for students to be involved in the learning process. The metaverse-based learning method is considered to have the potential to train students to think creatively when facing what is new in technology to be used in learning. In metaverse-based learning, students learn independently to use learning systems that are highly dependent on infrastructure, namely internet connections, metaverse platforms and mobile devices. Thus, metaverse-based learning is expected to improve student learning outcomes.

IV. RESEARCH LIMITATION

The research has a limitation: Timing of the Research: (1) **Timing of the Research** - The research was conducted during a specific period - after the COVID-19 pandemic. This timing is essential because the pandemic brought about significant changes in various aspects of life, including education and internet usage. Understanding when the research was conducted helps to contextualize the limitation. (2) **Internet Connection Stability** - The main limitation identified in the research is related to the stability of internet connections. This suggests that the researchers might have relied on the internet for data collection, communication, or other critical aspects of their study. (3) **COVID-19 Pandemic Impact** - The COVID-19 pandemic had a profound impact on the world, leading to a surge in remote work and online learning. This sudden and unprecedented demand for internet services put considerable strain on internet infrastructure, leading to connectivity issues in some areas. (3) **School's Inability to Provide Effectively** - The limitation statement implies that the school under study struggled to provide something effectively due to unstable internet connections. This «something» could be various things, such as online classes, resources, support, or services.. (4) **Implications for Research Findings** - The instability of internet connections during the study period might have affected the research outcomes. For example, if the research involved surveys or online interviews, participants might have encountered difficulties in participating fully due to connectivity issues. This could potentially impact the validity and reliability of the research findings.

V. CONCLUSION

The results of this study indicate that there are differences in digital class game-based learning strategies when compared digital class metaverse-based learning strategies with Mathematics learning outcomes. Learning independence of students is a consideration of learning outcomes in Mathematics, it turns out that there are findings in this study that students who are taught using game-based learning strategies have differences in learning outcomes in Mathematics with metaverse learning strategies. Game-based mathematics learning strategies can be implemented to support digital learning without an internet connection. At the same time, metaverse-based mathematics learning can be implemented to support learning using an internet connection.

Future research is carried out by storing learning outcomes on internet servers, and applications can run on all brands and resolutions of mobile devices.

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