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The Use of Digital Media to Improve Student Activity and Learning Outcomes in Mathematics Learning

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Abstract
This study aims to improve the learning outcomes of grade 2 students of SD Muhammadiyah 4 Kasembon in mathematics lessons in increasing student activation, achievement, and learning completeness using digital media. The subjects of this research are grade 2 elementary school students. Research subjects are used to obtain data on the variables to be studied, so that research can achieve goals and produce quality content. The method used in collecting Digital Game Based Learning (DGBL) data taken during the learning process. The results showed a significant increase in student activeness and learning achievement after the application of digital media, with the level of activeness reaching 75% in the second cycle and the average student score exceeding the Minimum Completion Criteria (KKM). The use of digital media such as interactive videos and educational game applications proved effective in attracting interest in learning, increasing motivation, and helping to understand mathematical concepts. The application of digital media use of Digital Game Based Learning (DGBL) model can attract students' attention and interest in learning, especially mathematics.
Keywords: Media Digital, Mathematics, Digital Game Based Learning, Learning Outcomes.

1. Introduction

At the elementary school level to the high school level, mathematics can be said to be a very important material to learn (Amalia & Khoiruddin, 2023; Mariyanto et al., 2023). Because mathematics as described will be used in solving important issues that may be encountered in reality. Based on research conducted by Haratua, et al (2025) explains that one of the learning materials that can shape a society to be able to compete in the modern era is learning mathematics education. Mathematics education in schools at all levels of education serves to prepare individuals who master technology and science. This indicates that to produce a generation of students who are able to compete to overcome social changes and make the next generation of nations that can make the Indonesian nation proud, it is necessary to emphasize learning mathematics from an early age (Mulbar & Zaki, 2018).

In addition, it is important to establish a relevant curriculum and update mathematics teaching methods. One promising approach is the Digital Game Based Learning (DGBL) model, which integrates elements of play in learning to increase student engagement (Kucher, 2021; Panskyi & Rowinska, 2021; Ray & Ilangovan, 2024). In Greek, math comes from the words mathein and mathenem which means learning. (Duha & Harefa, 2024). In elementary school children whose way of thinking is still oriented to real things, the concept of mathematics must be given very carefully. The goal of learning mathematics is not real, but abstract with the branch of knowledge becoming more and more developed and complex. Mathematics learning is a series of activities that are specially designed with the aim of creating a learning environment that allows a person to learn mathematics well, and this series of activities is teacher-centered but involves the activeness of students in its implementation (Milaturrahmah et al., 2017).

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The application of the Digital Game Based Learning (DGBL) model not only serves to attract students' interest, but also to provide a more interactive and meaningful learning experience (Chang et al., 2018). Digital games provide real-world contexts that allow students to apply mathematical concepts in the real world (Jannah et al., 2024). For example, through challenging games, students can learn about percentages by managing virtual finances or understanding geometry through building construction in simulations. In this way, mathematics is no longer seen as just a difficult subject, but as a practical tool that has applications in various aspects of life.

In addition, DGBL can also facilitate collaborative learning, where students can interact with each other in a play environment. Involvement in team-based play can help students build the social and communication skills necessary in modern society (Koutantou & Rangoussi, 2022). In this setting, they can discuss and solve problems together, improving their understanding of mathematical concepts and encouraging them to share knowledge with each other. Research shows that students who study in groups tend to have a better understanding of the subject matter compared to those who study individually (Hidayati et al., 2022).

However, to optimize the effectiveness of DGBL in mathematics education, it is important for educators to select and develop games that fit the learning objectives. Games should be designed with students' skill levels and curriculum content in mind, as well as provide appropriate but non-frustrating challenges (Özkaya et al., 2024). By integrating appropriate learning elements, such as positive reinforcement and constructive feedback, DGBL can be an effective strategy in improving math understanding and building the critical skills needed to succeed in the digital age (Martin et al., 2020). Educators also need to periodically evaluate the impact of this model in the learning process and adjust their strategies based on the results obtained.

Mathematics learning activities do not only aim to master mathematical material, but mathematical material is considered as a tool to master the expected skills in accordance with the learning objectives (Manurung & Laoli, 2021). Therefore, there needs to be an adjustment between the competencies that have been mastered by students and the scope of mathematics subjects studied. By leveraging modern technology and innovative approaches to learning, such as project-based learning and DGBL, students can be more actively engaged and gain a deeper understanding of mathematical concepts. A mathematics competency standard is a basic mathematical ability that a student must achieve as a result of an evaluation of his or her learning in a mathematics subject (Mardiana et al., 2023).

Mathematics subjects are often considered difficult because they use many formulas and question language that are not understood and complicated and require high concentration by students, especially for elementary school students (Agusfianuddin et al., 2024). This is where the DGBL model can come into play, as digital games can adapt to students' level of understanding, provide immediate feedback, and introduce math concepts in a fun context. This causes some students to be less enthusiastic and tend to be passive in the learning process, which can ultimately have an impact on the achievement of their learning outcomes (Agusfianuddin et al., 2024). The concept of materials and methods used in learning are also factors in this subject that students often avoid. According to Corneluis quoted by Abdurahman, there are five reasons for the need to learn mathematics, namely (1) mathematics is a means of clear and logical thinking, (2) a means of solving everyday problems, (3) a means of recognizing relationship patterns from generalizations, (4) a means of developing creativity, and (5) a means of increasing awareness of cultural developments in the era of digitalization (Pasaribu, 2013).

Based on the information collected by the researcher from students, the causes of the lack of student activity in mathematics learning in the classroom and the lack of learning outcomes.

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This can be seen from the mastery of materials that are still far from the specified strandar. Most students feel bored with the methods used, namely lectures and writing. This shows that the methods and media used by teachers must be innovative and varied. From a number of learning media, the use of digital media is considered suitable to overcome this problem. The use of digital media in the learning process is one of the innovations that has begun to be widely applied in various schools. This medium allows students to learn through more engaging conceptual visualizations through learning videos and interactive game applications, thus helping students understand the material more easily and effectively, not fixated on just one method. The purpose of this research is to improve the activation, achievement, and completeness of student learning by using digital media.

Referring to the results of the research, the researcher is interested in implementing digital media in several subjects, but its application in mathematics learning still needs to be evaluated in depth. This learning model is considered to be able to foster students' skills in understanding concepts, analyzing, and thinking critically. With this learning model, a more enjoyable teaching and learning atmosphere will be created, and can also trigger students' attention, motivation, and interest in learning. In line with that, this research is expected to provide new insights for students and teachers regarding the effectiveness of digital media as a tool to increase student active participation, as well as provide relevant suggestions for the development of more innovative and interactive learning methods in elementary schools.

2. Method

In the implementation of research using digital media in mathematics learning in elementary schools, it is inseparable from the use of the right method for appropriate results. The method used is Digital Game Based Learning (DGBL). According to Dan, et al (2024) Game Based Learning is a form of learning centered on learning that uses electronic or digital games for learning purposes. This learning process utilizes digital games in learning to attract students' attention and interest in learning, especially mathematics in elementary school. The implementation of this research was carried out at SD Muhammadiyah 4 Kasembon with the research subjects of grade 2 students consisting of 5 male students and 5 female students at SD Muhammadiyah 4 Kasembon.

This study uses quantitative data in the form of the success of the learning process which is generally measured based on the average learning outcome score and the percentage of student learning completeness, especially mathematics. According to Sugiyono (2013) states that the use of descriptive statistics such as averages and percentages is the right way to analyze data on learning outcomes and student activities in educational research, as it can provide an idea of the level of learning success.

In this study, student activity data obtained through observation sheets during the learning process was used. The aspects observed included student participation in asking questions, answering questions, involvement in discussions, and learning motivation. Student learning outcome data is obtained from formative tests as an assessment instrument to measure students' understanding of the material being taught. In general, the success of the research can be seen from the average score and percentage of the number of student completions. The analysis was carried out using simple statistics as follows:

$$\text{Percentage of activity} = \frac{\sum \text{number of active students}}{\sum \text{students in class}} \times 100\%$$

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$$\text{Percentage of completness} = \frac{\sum \text{number of students who complete learning}}{\sum \text{students in class}} \times 100\%$$

If in these two aspects there is an improvement, then this research is said to be successful.

3. Results and Discussion

Learning can be described as a process, meaning that during learning there will be a process of observation, creation, analysis, problem or problem solving, listening, and practice (Sukrajh & Adefolalu, 2021). Therefore, during the learning process, teachers can support students and get input from them so that students can carry out the procedures mentioned above. There are four main concepts that must be understood during learning, namely learning to know, learning to do, learning to live together, and learning to be (Hartono et al., 2022).

There are several factors that lead to significant learning success. These factors can be divided into two categories: internal factors and external factors. Internal factors, such as students' learning habits, have a significant correlation with learning outcomes. In this case, good study habits can improve the efficiency and effectiveness of student learning. In addition, ability, interests, talents, effort, motivation, attention, weaknesses, and resilience are equally important components. Other grade-level influences that affect learning outcomes include physical and non-physical environments, as well as the curriculum of schools, teachers, and other students (such as the classroom atmosphere during lessons, which is completely carefree and uncomfortable) (Brezavšček et al., 2020; Burke et al., 2024).

The cognitive development of elementary school students is very dynamic (Hasan et al., 2023; Hasibuan et al., 2024; Oktaviani et al., 2023). The reference is to logical relationships between concepts or schemes to foster cognitive abilities in the concrete operational phase in elementary school students (Lu, 2024). There are many theories that explain how children learn, but Jean Piaget's theory is the most famous. Children aged 7-11 years are in the Concrete Operational stage, they begin to be able to think logically about concrete objects and real situations, in contrast to the more dominant Preoperational stage at the age of 2-7 years. At the Concrete Operational stage, the five senses and movement are no longer the only main factors in the development of children's knowledge. Instead, the child begins to use mental representations to understand objects, interpersonal relationships, space, and time (de Ribaupierre, 2015; Polydoros et al., 2025).

Based on this theory, 2nd grade elementary school students do not only rely on mental representation and movement in building their knowledge, but need media that they can see in their form, therefore the author chooses digital media as a tool to make it easier for students in mathematics lessons, because the author considers that the use of digital media with the DGBL method is very appropriate to help 2nd grade students of SD Muhammadiyah 4 Kasembon in learning mathematics. The use of digital media is expected to increase maximum learning outcomes and make it easier for students to understand the material presented visually and interactively (Simorangkir et al., 2024).

In the pre-cycle stage, initial observations were made to determine the level of student activeness in the learning process. The teacher together with the principal and colleagues observed the learning process which had not used effective media and methods. The aspects observed included maximum student participation, involvement in discussions, and learning motivation. Of the 10 students in class 2, only about 30% were active in asking questions, answering questions, and engaging in discussions, while the rest were more passive by just listening or waiting for directions from friends. Many students clearly showed a lack of interest in the learning material, which could be seen from their lack of focus and frequent chatting

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during the lesson. The teacher then reflected on the results of the pre-cycle observations as evaluation material and a reference for observations at the next cycle stage.

Figure 1.
*Percentage of Pre-Cycle Student Activity*

The implementation of the first cycle stage includes planning in accordance with the reflection carried out by the researcher on the problems in the pre-cycle stage, namely the lack of motivation and activeness of learning mathematics in the classroom using the lecture method for grade 2 students of Muhammadiyah 4 Kasembon Elementary School. The stages of the 1st cycle learning process start from preparing a learning assignment plan (RPP) by adapting it to student learning techniques and methods, identifying learning materials that are in accordance with the basic competencies (KD) in the independent curriculum for the 2024/2025 school year, developing digital media that includes interactive videos explaining mathematical concepts to mathematical multimedia game applications, and preparing assessment instruments in the form of student learning observation sheets and formative tests to evaluate learning outcomes.

The implementation of the phase I cycle was carried out in the learning process for 2 meetings with the initial step of the teacher opening the lesson by greeting students and providing motivation, then conveying learning objectives and introducing digital media that would be used. Then the teacher entered the core activities, namely: 1) playing interactive videos that explain the concept of number operations 2) the teacher uses multimedia presentations to provide examples of problems and how to solve them 3) assigning students to solve problems in digital applications and guiding them 4) inviting students to play interactive games through digital applications about learning materials, and 5) conducting assignment activities to determine students' understanding of the material taught.

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Figure 2.
Cycle Stage I
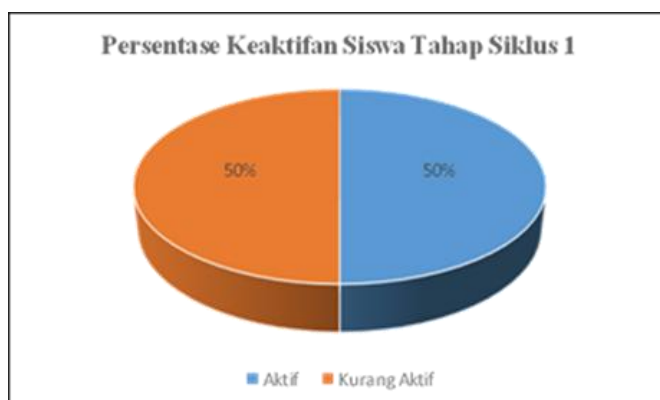
The reflection carried out by the teacher in cycle I was used as a reference for the implementation of cycle II. The activities in cycle II were the same as cycle 1, namely: 1) The teacher again compiled a more detailed lesson plan by strengthening the use of interactive digital media, such as videos explaining mathematical concepts and multimedia game applications that were more varied and interesting, 2) The teacher provides motivation and conveys learning objectives and introduces the digital media that will be used, 3) Furthermore, students are given the task of solving problems through digital applications accompanied by the teacher to ensure their understanding, 4) The teacher gives evaluation assignments in the form of formative tests and observes student activeness during the learning process.

Figure 3.
Cycle Stage II

Based on the data of the second cycle, it shows that the percentage has increased by 75%. This increase shows that the expected results in this study have been achieved, namely the average achievement of student learning outcomes in KKM. The following is the percentage of comparison of student learning outcomes in mathematics division materials during pre-cycle, cycle I and cycle II.

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Figure 4.
Comparison of Completeness
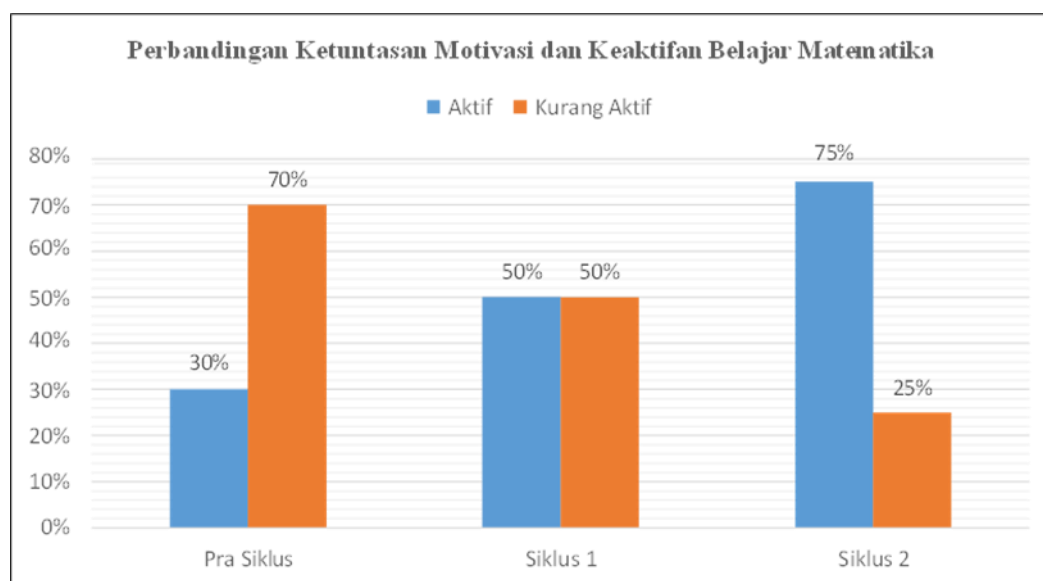
The results of the study illustrate that by applying the use of digital media in learning mathematics at SD Muhammadiyah 4 Kasembon can attract students' attention and interest in learning. By looking at the results in cycle II, the researcher ended the research only until cycle II. The Digital Game Based Learning (DGBL) learning model makes students interested in mathematics lessons by utilizing digital games in learning. Learning is increasingly attracting students' interest because it is done by direct practice, which can be interpreted as learning while playing.

With the implementation of DGBL, mathematics learning not only becomes fun, but can also improve students' problem-solving skills and creativity (Hidayat et al., 2024). This approach is believed to be able to present a practical context that strengthens the understanding of mathematical concepts, thereby making students feel more confident in facing academic challenges in the future. According to Kucher (2021) DGBL also has the potential to provide immediate feedback, allowing students to assess their progress in real-time and make necessary modifications to learners' learning strategies.

Furthermore, the use of digital media in game-based learning can facilitate the development of social and collaborative skills as students work in teams to complete tasks. This is essential in building a positive learning community, where students can learn from each other and develop interpersonal skills that will be beneficial outside of the classroom environment (Nadeem et al., 2023; Slattery et al., 2024). Therefore, the step to integrate DGBL in the mathematics education curriculum, especially for grade 2 elementary school students, is a strategic step that is expected to bring positive changes to the way students understand and enjoy learning mathematics.

4. **Conclusion**

Based on the results of the research, it can be concluded that the use of digital media in mathematics learning in elementary schools can increase student activity and learning outcomes. The use of digital media in mathematics learning has been proven to be able to attract interest and increase student involvement in the learning process. This can be seen from the increase in the percentage of student activity in each cycle, up to 75% in the second cycle, as

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well as the achievement of student learning outcomes above the Minimum Completeness Criteria (KKM). So the application of interactive media can help students understand mathematical concepts better, as well as increase students' interest and motivation to learn. This method can make it easier for students to understand mathematical concepts, so that it has a positive impact on their motivation and learning achievement.

There are several suggestions that can be considered to increase the effectiveness of using digital media in mathematics learning in elementary schools, namely the implementation of continuous training programs for teachers to master the use of digital media well. In addition, it is important to integrate digital media in the mathematics curriculum in primary schools systematically, with modules that support interactive learning. Schools also need to ensure the availability of adequate digital resources, including stable internet access and appropriate devices. Conducting regular evaluations of the use of digital media in learning is essential to assess its impact in the long term. Finally, involving parents in learning by providing information on how to support children at home is also a useful step. By implementing these recommendations, it is hoped that the use of digital media in mathematics learning can become more effective and provide better outcomes for students.

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