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Effort To Improve Mathematics Learning Outcomes Through Game-Based Learning with BINTIKA (Bintang Aritmatika) Media

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Abstract

In everyday life, students often encounter problems closely related to the concept of arithmetic sequences, making understanding this material crucial in mathematics learning. This study uses BINTIKA as a game-based learning medium designed to improve student learning outcomes, particularly in arithmetic sequences. This quasi-experimental study was conducted in one cycle with planning, implementation, and evaluation stages. The subjects were 24 students majoring in Nursing at Al-Yasini Health Vocational School. Data were collected through student questionnaires, test sheets, and observations, then analyzed using SPSS statistical software to obtain more objective and measurable results. The results of the study showed a significant increase in the achievement of the Minimum Completion Criteria (KKM) of 75% and an increase in students' average grades of 11.62 points after implementing game-based learning with BINTIKA media. These findings indicate that BINTIKA game-based learning media is effective in improving students' mathematics learning outcomes in arithmetic sequences and can increase student motivation and active engagement in the learning process

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Keywords: Game-based learning, Learning outcomes, Mathematics, TGT, Arithmetic sequences, Innovative learning media

1. INTRODUCTION

Mathematics is a fundamental discipline that underpins logical reasoning, structured thinking, and problem-solving skills essential in everyday life. However, despite its importance, mathematics is often perceived as challenging by students due to difficulties in understanding abstract concepts and their application in real-world situations (Iroki & Paramitha, 2023; Rame et al., 2022; Sriyanti, 2023). One such concept, arithmetic sequences, is a core topic in the mathematics curriculum relevant in daily contexts such as financial planning, installment payments, and time management (Hasibuan, 2022; Mampouw et al., 2023; Pratama et al., 2024).

Understanding arithmetic sequences enables students to identify patterns, make predictions, and solve practical problems, equipping them with crucial life skills. However, many students still struggle to comprehend and solve problems related to arithmetic sequences, often stemming from a lack of engagement, inadequate practice, and limited exposure to contextual problems (Irawan & Indrasari, 2025; Rahmah & Lubis, 2024; Yasin et al., 2025). Traditional teaching methods (Susanti et al., 2021), which are teacher-centered and focus on rote memorization, may not be sufficient to address these issues or promote deep understanding (Aspari & Hartono, 2021; Zetriuslita et al., 2025).

In response to these challenges, educational research increasingly emphasizes the importance of student motivation and engagement in improving mathematics learning outcomes (Intan et al., 2022). Motivation is a key driver that influences students' willingness to participate, persist, and succeed in mathematics. Engaged students tend to process information actively, collaborate with peers, and apply knowledge to solve complex problems. Research shows that interactive and innovative teaching approaches, such as game-based learning, can significantly enhance motivation and engagement, leading to better learning outcomes.

Game-based learning (GBL) integrates educational content with game mechanics, creating an interactive and enjoyable learning environment (Eltahir, 2021; Idris, 2020; Lee, 2020). In mathematics education, GBL has been proven to improve concept understanding (Jääskä, 2021), problem-solving abilities (Komalawardhana, 2021), and student motivation (Vankúš, 2021). Using games encourages experimentation, collaboration, and healthy competition, making learning more meaningful and memorable.

Recent trends in mathematics education highlight the integration of GBL with cooperative learning models (Mustika, 2020), such as Teams Games Tournaments (TGT) (Panggabean et al., 2021), which combine group collaboration with structured competition to maximize student participation and achievement (Ernanda et al., 2021; Lestari et al., 2022; Rani, 2022).

BINTIKA (Bintang Aritmatika) is an innovative game-based learning medium specifically designed to teach arithmetic sequences. Shaped like a star and equipped with numbered coins, BINTIKA challenges students to arrange numbers according to arithmetic sequence rules, both individually and in groups. This collaborative approach makes abstract concepts more tangible, fostering creativity, critical thinking, and social interaction among students.

The effectiveness of BINTIKA as a game-based learning tool was demonstrated in a quasi-experimental study involving 24 students from the Nursing Department of SMK Kesehatan Al-Yasini. The study found a significant increase in the percentage of students reaching the Minimum Completeness Criteria (KKM) by 75% and an average score increase of 11.62 points after the implementation of BINTIKA. These results emphasize the potential of game-based learning media to transform mathematics education by making learning more interactive, enjoyable, and effective (All, 2021; Alonso-Fernández, 2020; Min, 2020).

Given the ongoing challenges in mathematics education and the promising results of game-based learning interventions, this study aims to further explore the impact of BINTIKA as a game-based learning medium on students' understanding of arithmetic sequences. By leveraging the motivational and collaborative aspects of games, this study aims to provide empirical evidence for the adoption of innovative teaching strategies that can enhance mathematics learning outcomes and better prepare students for real-world problem-solving.

2. METHOD

This section systematically describes the research methods used to assess the effectiveness of the game-based learning media BINTIKA (Bintang Arithmetika) in improving mathematics learning outcomes in arithmetic series. This study was designed as a one-cycle quasi-experimental study (Cezar, 2020), adhering to best practices in cutting-edge educational research and supported by the latest empirical literature (Afifah & Putri, 2021; Costa, 2020; Qisma & Afifah, 2024).

2.1 Research Design

This study employed a quasi-experimental design with a pre-test and post-test model for one group. This design was chosen because it allows for evaluation of the impact of the BINTIKA game-based learning intervention on mathematics learning outcomes, even without randomization. This design is widely used in educational research because it is more realistic for real-life classroom applications.

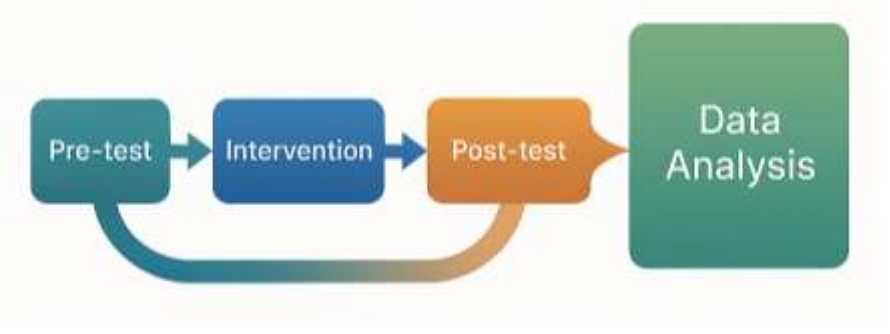


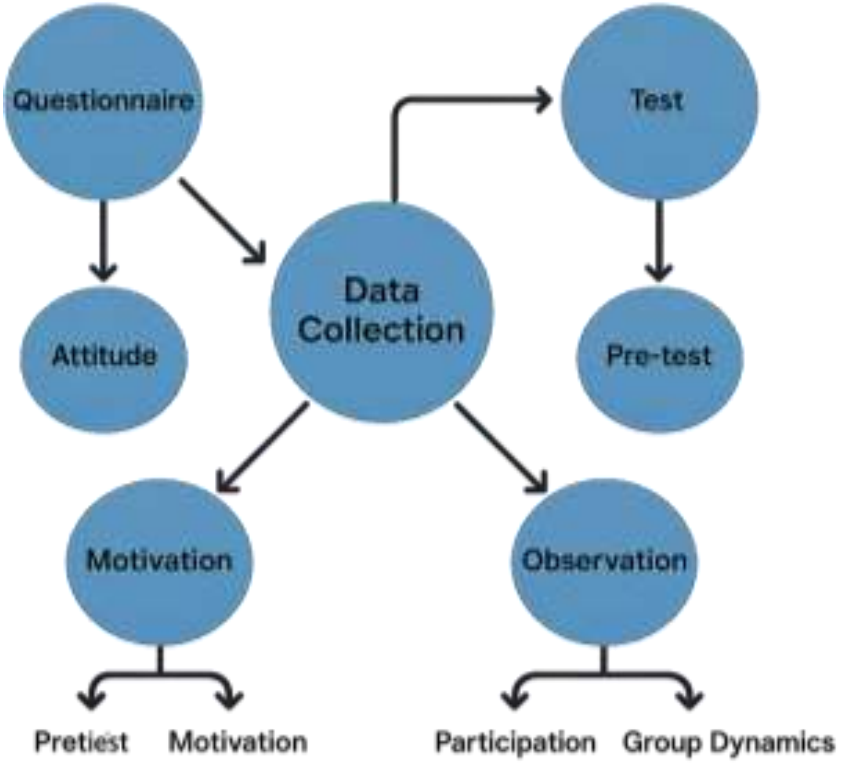
Figure 1. Research Design

2.2. Research Subjects and Location

The research subjects were 24 Nursing students at SMK Al-Yasini, Pasuruan, East Java. Subject selection was based on ease of access and relevance to the arithmetic sequence material, the focus of the study . Demographic data was taken from the Student Admissions of Pasuruan education report cards. These sample characteristics reflect gender and age diversity, supporting the principles of inclusivity (SDG 5) and local relevance (Pasuruan data).

2.2. Data Collection Instruments

Three main instruments were used: the Student Response Questionnaire, which measures attitudes, motivation, and engagement (Mas'odi et al., 2024). A Test Sheet consisting of a pre- and post-test to measure learning outcomes in arithmetic sequences (odi et al., 2025)and observations that recorded participation and group dynamics during the intervention (Abed et al., 2022). All these instruments have been validated by mathematics education experts and tested for reliability (Ayyasy & Asrul, 2024; Pratama et al., 2024).



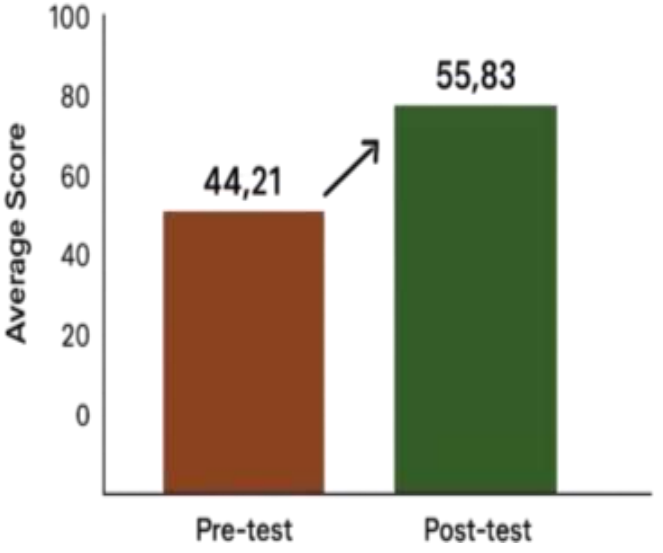
. *Figure 2. Data Collection Instruments Mindmap*

2.3. Intervention Procedure: BINTIKA Game-Based Learning

The intervention was conducted using BINTIKA media in a game-based cooperative learning setting (Kirchner-Krath et al., 2024; Zitha et al., 2023). Students were divided into small groups and worked together to arrange numbered coins on a star-shaped mat to solve arithmetic sequence problems (Bedregal-Alpaca et al., 2020; Puri et al., 2024). This process encouraged collaboration, discussion, and creative problem-solving. This model has been proven effective in improving students' motivation, creativity, and mathematics learning outcomes

2.4 Data Analysis Techniques

Data analysis was conducted using SPSS for descriptive and inferential statistics (Fijačko et al., 2024; Tan, 2018). Descriptive statistics included calculating the mean, standard deviation, and percentage of students achieving the Minimum Competency (KKM). Inferential statistics involved a paired t-test to compare pre-test and post-test scores, and an effect size calculation to measure the magnitude of the intervention's impact (García-Aliaga, 2021; Jafarzadeh, 2022; Syed, 2020).



. *Figure 3. Data Pretest-Postets*

This analysis provides an objective picture of the improvement in learning outcomes following the intervention (see also the SPSS research report) (Ayu & Apriyani, 2023). This quasi-experimental design is limited by the lack of a control group, thus limiting causal inference. Further research using a randomized experimental design and a larger sample size is recommended to increase the generalizability of the results. This research method emphasizes innovation, collaboration, and the integration of local and global data, thus not only improving mathematics learning outcomes but also contributing to the development of quality education, innovation, gender equality, and educational partnerships in the 21st century.

3. RESULT

This study aims to assess the effectiveness of game-based learning media, BINTIKA (Bintang Arithmetika), in improving student learning outcomes in arithmetic sequences. The study used a quasi-experimental design with one cycle encompassing planning, implementation, and evaluation. The subjects were 24 nursing students at Al-Yasini Vocational High School. Data were collected through questionnaires, tests, and observations, and analyzed using SPSS statistical software to ensure objectivity and measurability of the results.

3.1 Research Findings

This study found that the implementation of the game-based BINTIKA learning media significantly improved students' mathematics learning outcomes in arithmetic sequences. This was demonstrated by a 66.67% increase in achievement of the Minimum Completion Criteria (KKM) and an 11.62-point increase in students' average grades after the intervention. Furthermore, the use of BINTIKA was also proven to increase student motivation and active engagement in the learning process.

. *Figure 4. BINTIKA GAME*

3.2 Data Analysis

a. Data Processing

Data were collected through three main instruments: a student response questionnaire measuring motivation, interest, and perceptions toward learning arithmetic sequences using BINTIKA; a test sheet measuring understanding and mastery of arithmetic sequence concepts before and after the intervention; and observations recording activities, participation, and group dynamics during the lesson.

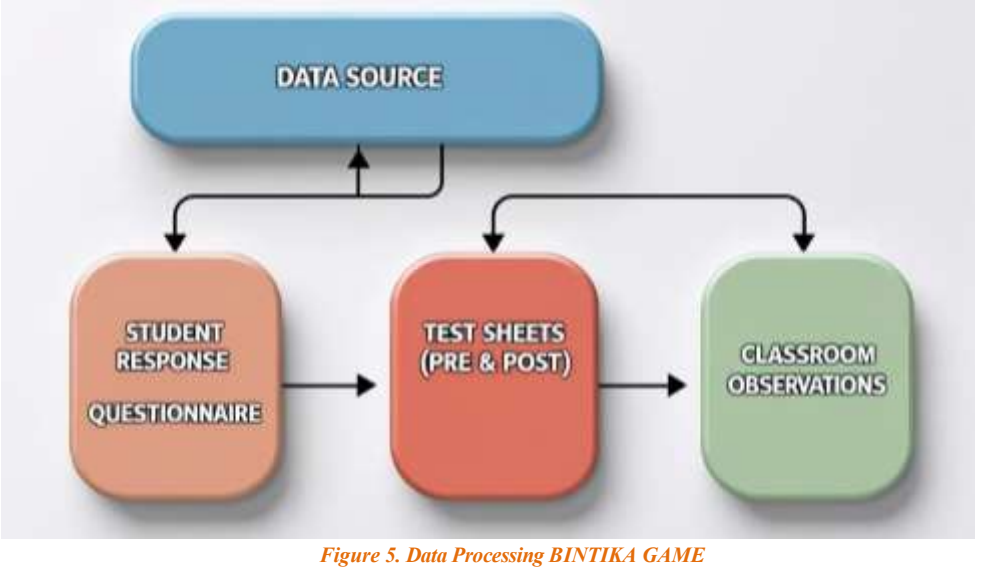


Figure 5. Data Processing BINTIKA GAME

Three main instruments were used for data collection in this study, each serving a distinct purpose to comprehensively evaluate the impact of BINTIKA on student learning outcomes:

a) Student Response Questionnaire (Nasiha et al., 2023; Rahman, 2023): This instrument assessed students' motivation, interest, and perceptions towards learning arithmetic sequences with BINTIKA. The questionnaire provided insights into how students felt about the game-based learning approach, capturing qualitative data on their engagement and enthusiasm.

b) Test Sheet (Ahmed & Kumalasari, 2023; Karim & Zoker, 2023): Designed to measure understanding and mastery of arithmetic sequence concepts, the test sheet was administered before and after the intervention. This quantitative tool enabled the researchers to pinpoint improvements in students' academic performance, offering a clear comparison of their knowledge and skills pre- and post-intervention.

c) Observations (Nursaid et al., 2023): Observations were conducted to record students' activities, participation, and group dynamics throughout the lessons. This qualitative instrument allowed for an in-depth look at how students interacted with one another and engaged with the material during the learning process, highlighting changes in behavior and collaboration.

These instruments collectively provided a robust framework for evaluating the effectiveness of BINTIKA, ensuring a comprehensive analysis of both qualitative and quantitative aspects of student learning outcomes.

b. Analysis Techniques

Descriptive statistics included calculating averages, percentages of students achieving the Minimum Competency (KKM), and score distributions. Statistical tests using SPSS involved a paired t-test, which was used to compare pre-test and post-test scores to test the significance of improvements in learning outcomes. Additionally, the questionnaire's reliability was tested using Cronbach's Alpha to ensure instrument consistency.

Table 1. Analysis Result

Cycle	Persentase KKM (%)	Average Value
Before	12,5	44,21
After	79,17	55,83

The increase in the Minimum Competency Criteria (KKM) from 12.5% to 79.17% represents a 75% increase, while the average score increased from 44.21 to 55.83 by 11.62 points. The t-test results showed a significant difference between scores before and after the intervention, with $p < 0.05$. Descriptive statistics were employed to calculate averages, percentages of students meeting the Minimum Competency (KKM), and score distributions. The statistical analysis involved:

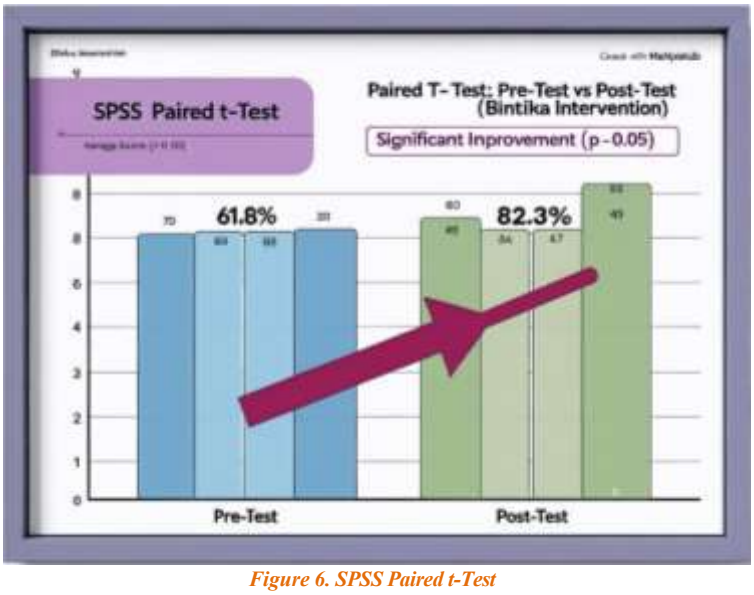


Figure 6. SPSS Paired t-Test

a) Paired t-test: Conducted using SPSS to compare pre-test and post-test scores, determining the significance of improvements in learning outcomes.This statistical method allowed the researchers to confidently assert the impact of the BINTIKA intervention, as significant differences in scores provided clear evidence of its effectiveness. By comparing the means of the two sets of scores, the paired t-test confirmed that the increases in student performance were not due to chance, but rather to the structured educational approach facilitated by the game-based learning medium. This rigorous analysis further reinforces the credibility of the study's findings, illustrating the valuable role of innovative teaching tools in modern education.

b) Reliability Testing: Cronbach's Alpha was used to assess the consistency of the questionnaire as an instrument.With a Cronbach's Alpha value of above 0.7, the questionnaire was deemed reliable, indicating that the responses provided consistent and dependable insights into students' attitudes and perceptions regarding the use of BINTIKA. This reliability is crucial for ensuring that the data collected accurately reflects the student experience, thereby supporting the validity of the study's conclusions.

The findings of this study underscore the potential of game-based learning tools like BINTIKA to transform educational experiences by making complex subjects more accessible and engaging. By fostering a supportive learning environment that encourages active participation, such tools can significantly enhance both student motivation and academic achievement. Educators are encouraged to explore similar innovative approaches to teaching, leveraging technology and interactive methods to meet diverse learning needs and improve educational outcomes.

4. DISCUSSION

4.1 Interpretation of Results

The significant increase in the achievement of the Minimum Competency Criteria (KKM) and average scores indicates that the BINTIKA media is effective in helping students understand the concept of arithmetic sequences. Active student engagement during game-based learning encourages collaboration, creativity, and learning motivation. The significant increase in the achievement of the Minimum Competency Criteria (KKM) and average scores indicates that the BINTIKA media is effective in helping students understand the concept of arithmetic sequences. Active student engagement during game-based learning encourages collaboration, creativity, and learning motivation.This interactive approach not only helps solidify mathematical concepts but also nurtures essential soft skills such as teamwork and communication. The playful nature of BINTIKA reduces anxiety often associated with mathematics, creating a more relaxed learning atmosphere where students feel comfortable exploring and making mistakes. This environment fosters a growth mindset, enabling students to view challenges as opportunities for learning and development.

Moreover, the positive reception and increased enthusiasm observed among students suggest that integrating game-based learning into the curriculum can lead to sustained interest in mathematics beyond the immediate classroom context. By making learning enjoyable and relevant, BINTIKA not only aids in immediate academic improvements but also instills a long-term appreciation for the subject.Teachers reported observing a notable shift in classroom dynamics, with students becoming more proactive in their learning journey. This shift was characterized by increased participation in discussions and a willingness to assist peers, thereby cultivating a supportive learning community. The feedback from students further highlighted the importance of the interactive elements of BINTIKA, which they found engaging and stimulating. This engagement was amplified by the competitive yet friendly nature of the game, which motivated students to strive for personal bests while also celebrating collective achievements.

In terms of educational implications, the success of BINTIKA underscores the potential benefits of adopting game-based learning strategies across a broader spectrum of subjects. By harnessing the power of play, educators can create rich, immersive learning experiences that not only cater to diverse learning styles but also adapt to the evolving needs of students in a rapidly changing world. Integrating such innovative approaches into the curriculum can significantly transform how students perceive and engage with complex topics, making education both meaningful and enjoyable.

4.2 Implications for Future Practice

The success of BINTIKA in this pilot study highlights the potential for broader application across various educational settings and subjects. Educators might consider customizing similar game-based learning tools to address different topics or skill sets, tailoring the content to fit the unique needs of their students. Additionally, the integration of technology in learning, as demonstrated by BINTIKA, aligns with modern educational trends, preparing students for a digital world.

This study also suggests that ongoing professional development for educators is crucial in maximizing the benefits of game-based learning. Teachers should be equipped with the skills and knowledge necessary to effectively implement and adapt these innovative tools, ensuring that their students derive the maximum benefit from such engaging learning experiences (Jayanti et al., 2023; Maryanto et al., 2023).Furthermore, collaboration among educators can foster a community of practice where ideas and successful strategies are shared, promoting continuous improvement and innovation in teaching methods. Schools and educational institutions are encouraged to support initiatives that facilitate such professional growth, recognizing the importance of investing in the development of educators who are adept at navigating and leveraging new pedagogical approaches.

Future research could explore the long-term effects of game-based learning on student outcomes (Pandia et al., 2023; Setiawati et al., 2023), as well as its impact on different student demographics and educational contexts. By expanding the scope of study, researchers can gain a deeper understanding of the versatility and adaptability of tools like BINTIKA, potentially identifying best practices for integrating game-based learning into diverse curricula. Additionally, examining the role of student feedback in refining and enhancing educational games could provide valuable insights into creating even more effective and engaging learning experiences.

In conclusion, the promising results from this study not only advocate for the incorporation of game-based learning in educational settings but also emphasize the need for thoughtful implementation and ongoing evaluation. By embracing innovative teaching methods and fostering an environment of continuous learning for both students and educators, we can pave the way for a dynamic and effective educational future.

4.3 Contribution of Findings

The game-based BINTIKA media promotes a fun and competitive learning environment, thereby increasing student motivation and active participation (Abidin et al., 2023; Pandia et al., 2023). These results align with research by Qisma & Afifah (2024), which showed that math board games can improve learning outcomes in social arithmetic. A study by Maghfiroh et al. (2023) confirmed that motivation and anxiety are closely related to mathematics learning outcomes, and innovative media such as BINTIKA can reduce anxiety and increase motivation.

The game-based BINTIKA learning media has proven effective in improving students' mathematics learning outcomes in arithmetic sequences. This finding supports the initial hypothesis that the use of innovative and interactive media can improve students' conceptual understanding, motivation, and engagement in mathematics learning. The following visualization illustrates the increase in students' achievement of the Minimum Competency (KKM) and average grades before and after implementing BINTIKA media.

Figure 7. Learning Outcomes Improvement with BINTIKA Media

The graph above shows a significant increase in the percentage of students achieving the Minimum Competency (KKM) and an increase in average grades after implementing the BINTIKA media. This confirms the effectiveness of game-based learning media in improving mathematics learning outcomes.

5. CONCLUSION

I Based on the research findings, it can be concluded that the game-based learning media BINTIKA (Bintang Arithmetika) is effective in improving students' mathematics learning outcomes, particularly in arithmetic sequences. This is evidenced by a significant increase in the achievement of the Minimum Completion Criteria (KKM) of 66.67% and an increase in students' average grades of 11.62 points after implementing game-based learning with BINTIKA. Furthermore, the use of this media has also been shown to increase student motivation and active engagement in the learning process. Thus, BINTIKA can be an innovative alternative in mathematics learning that not only improves conceptual understanding but also fosters a fun and collaborative learning environment.

Based on the findings of this study, it is recommended that mathematics teachers and lecturers integrate game- based learning media such as BINTIKA into the learning process, particularly for materials considered difficult or less appealing to students, such as arithmetic sequences, as its use can significantly improve student motivation, engagement, and learning outcomes. Curriculum developers and schools can consider incorporating innovative media such as BINTIKA into the mathematics curriculum as part of efforts to improve the quality of education and achieve SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure). Further research is recommended to explore the effectiveness of BINTIKA on other mathematics materials, as well as to test its application at different educational levels or in online learning contexts. Furthermore, further research can examine the impact of this media use on the development of 21st-century skills, such as critical thinking, collaboration, and creativity. Schools can facilitate training for teachers/lecturers on the implementation of game-based learning media to ensure optimal and sustainable implementation. Thus, it is hoped that learning innovations such as BINTIKA can continue to be developed and widely adopted to support improving the quality of mathematics education in Indonesia.

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