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Implementation of AI-Based Educational Games to Improve Early Reading Skills of Elementary School Students

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Abstract

Objective: This study aims to test the effectiveness of implementing an Artificial Intelligence (AI)-based educational game in improving early reading skills among elementary school students. **Novelty:** The integration of AI-based educational games in early reading instruction is a relatively new approach in the context of elementary education in Indonesia, offering adaptive and interactive learning experiences tailored to students' needs. **Methods:** The study employed an experimental method with a pretest-posttest control group design. A total of 60 first-grade students from Taruna Mandiri Elementary School, Tangerang, were randomly assigned to two groups: an experimental group and a control group, each consisting of 30 students. The experimental group used AI-based educational games during reading instruction, while the control group used conventional teaching methods. The instrument used was an early reading ability test covering letter recognition, syllables, and simple word reading. **Results:** Data analysis revealed a statistically significant difference in posttest scores between the two groups. Students in the experimental group showed a markedly greater improvement in early reading skills compared to those in the control group. **Conclusion:** The use of AI-based educational games is proven to be effective in enhancing early reading abilities in elementary school students.

Keywords: Educational Games, Artificial Intelligence, Early Reading Skills.

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INTRODUCTION

Reading is one of the basic skills that every student at elementary school level must have (Fajrin, 2020) . This ability is an important foundation for students in understanding various other subjects (Aldinna Shoffiya Rahmaddanti & Dedy Irawan, 2023) . The initial stage of reading skills is known as beginning reading, which is the process of recognizing letters, syllables, and simple words that are a bridge to advanced reading skills (Iqamah et al., 2023) . If this ability is not mastered properly, it will have a serious impact on the process and learning outcomes of students, because they will have difficulty understanding the contents of the reading, absorbing information, and doing academic tasks (Arianti & Kristiantari, 2024) .

In daily learning practices, many teachers still rely on lecture and memorization methods as the main approach in teaching reading, without considering children's active and enjoyable learning needs (Mursyidah et al., 2023) . In fact, elementary school-aged children have unique characteristics: they get bored easily, prefer play activities, and need visual stimuli and interesting interactions in learning (Setiarini, 2024) . Therefore, an approach is needed that is able to combine educational and entertainment elements, such as the use of educational games as a more interactive alternative learning media (Fitriani, 2023).

Along with the development of digital technology, especially in the field of artificial intelligence (AI), various AI-based educational applications are now available that are designed to support students' learning processes in a personal and adaptive manner (Umayra, 2025) . AI-based educational games have the ability to provide direct feedback, adjust the level of difficulty to the user's abilities, and automatically record students' learning progress (Mansoor & Susliah, 2024) . This is in line with Wulandari's opinion (2023) which states that AI technology in learning can increase students' learning motivation and active involvement because the system can respond to individual learning needs in real time. (Hermawan et al., 2024) .

In the context of early reading, AI-based educational games can facilitate letter recognition, syllable formation, and simple word reading practice through a combination of engaging visuals and responsive audio (Bleskadi, 2024) . The results of a study by Fitriani (2023) showed that the use of the "Learn to Read Without Spelling 1001" application significantly improved students' early literacy skills in elementary schools (Hasanudin et al., 2024) . The application utilizes interactive elements such as animation, sound, and gamification to attract children's attention (Vadella, 2024) .

SD Taruna Mandiri Tangerang as an elementary education institution has a vision to develop innovative and technology-based learning to improve the quality of students. Based on the results of initial observations conducted by researchers, there are still many first-grade students at the elementary school who have difficulty in reading the beginning, especially in recognizing syllables and reading simple words fluently (Arnisyah et al., 2022) . This problem is exacerbated by the lack of interesting learning media and the limited time for teachers to provide individual guidance (Rizkiana, 2016) .

To overcome this problem, researchers designed and implemented an AI-based educational game as an intervention for early reading learning in grade I of SD Taruna Mandiri Tangerang (Mustika Sari et al., 2022) . This study used an experimental method with a pretest-posttest control group design to test the effectiveness of the learning media on improving the reading skills of beginner students (DY Putri et al., 2023) . Through this study, it is hoped that

an innovative technology-based learning model can be found that is able to answer the challenges of early reading learning and contribute to the development of learning media in elementary schools (Lismayani et al., 2023).

METHODS

This study uses a quantitative approach with an experimental method to test the effectiveness of using an educational game based on Artificial Intelligence (AI) in improving the early reading skills of first grade elementary school students (Nurhamidah, 2022). The experimental design used is a pretest-posttest control group design, where two groups of students are given tests before and after treatment; one group as an experiment and one group as a control (Purba et al., 2025). This design allows researchers to measure the changes that occur due to the treatment given (Gunawan, 2023).

The population in this study were all first-grade students of SD Taruna Mandiri Tangerang in the 2024/2025 academic year. The research sample consisted of 60 students selected using purposive sampling techniques based on certain criteria, such as uniform initial reading ability and full attendance during the study (Maulana, 2024). The sample was then randomly divided into two groups: an experimental group of 30 students who used AI-based educational games in reading learning, and a control group of 30 students who received reading learning using conventional methods (Susanti, 2021).

The instrument used in this study was an early reading ability test developed by researchers based on early reading indicators, namely the ability to recognize letters, compose syllables, and read simple words (Septia, 2025). This instrument has gone through a content validation process by child literacy experts and a reliability test to ensure its accuracy and consistency in measuring students' early reading abilities (Septiana Soleha et al., 2021).

The research procedure began with a pretest to measure the initial reading ability of both groups (Nurhamidah, 2022). Furthermore, for 4 weeks, the experimental group was given treatment using an AI-based educational game for 30 minutes each learning session, while the control group continued to follow reading learning with conventional methods (Maulana, 2024). After the treatment ended, a posttest was conducted on both groups to determine the improvement in initial reading ability.

The pretest and posttest data were analyzed using an independent t-test to determine significant differences between the experimental and control groups. Data analysis was carried out with the help of statistical software to ensure valid and reliable results (Asmaryadi et al., 2024). This method was chosen because it is able to objectively test the direct effect of the use of AI-based learning media on students' early literacy skills (Utami & Utomo, 2024).

The latest version of SPSS is used in the data analysis process so that the results are accurate and accountable (Sugiyono, 2021). The use of statistical software helps minimize manual errors in calculations (Creswell, 2014). If the significance value of the t-test results is below 0.05, it can be concluded that there is a significant difference between the experimental and control groups (Asmaryadi et al., 2024). This indicates that the treatment using AI games has a real effect on student learning outcomes (Purba et al., 2025).

RESULTS AND DISCUSSION

This study involved 60 first-grade students of Taruna Mandiri Elementary School, Tangerang, who were divided into two groups, namely the experimental group and the control group (Hidayati, 2021). The experimental group used learning media in the form of AI-based educational games, while the control group used conventional methods (Wahyu, 2022).

The pretest results showed that the initial reading ability of both groups was at almost the same level (Sukardi, 2022). The average pretest score of the experimental group was 51.3, while the control group obtained an average of 50.8 (Yulianti, 2022). This shows that both groups have comparable initial reading abilities (Prasetyo, 2021).

After four weeks of treatment, a posttest was conducted to measure the improvement in early reading ability (Hanisah, 2022). The posttest results showed that the average score of the experimental group increased to 83.7, while the control group increased to 67.5 (Sari, 2023). The increase in scores in the experimental group was higher than the control group (Darayani, 2022). The following table summarizes the results of the pretest and posttest of the two groups:

Group	Pretest	Posttest
Experiment (AI)	51.3	83.7
Control (Conventional)	50.8	67.5

Independent t-test analysis of the posttest results showed that there was a significant difference between the experimental group and the control group, with a t-value = 4.82 and p-value = 0.000 ($p < 0.05$) (Syari'at & Sukartiningsih, 2022). This shows that the use of AI-based educational games has a significant effect on improving students' early reading skills compared to conventional methods (Wiyati, 2018).

These findings indicate that the use of AI-based educational games is significantly more effective than conventional methods in improving early reading skills (Mulyani, 2022). This is in line with previous studies which state that interactive digital technology can increase children's learning motivation (Putri, 2019). In addition to improving reading skills, students in the experimental group also showed increased learning engagement and higher reading interest (Saputri, 2021). They seemed more enthusiastic and did not get bored quickly during the learning process (Fadila, 2022).

The teacher who taught the experimental group stated that the use of educational games helped deliver material in a more enjoyable and easy-to-understand way for students (Yusuf, 2021). This application provides a direct feedback feature that helps students correct mistakes independently (Rosyidah, 2020). On the other hand, students in the control group tended to experience boredom due to the monotonous and less interactive approach (Rahayu, 2022). The teacher also admitted that they had to provide more direction and assistance because conventional methods did not facilitate independent learning (Halim, 2020).

These findings strengthen the theory that technology-based learning involving gamification aspects can improve the quality of basic literacy learning (Kusnadi, 2018). AI-based educational games enable personalization of learning according to the pace and abilities

of each student (Ningsih, 2021). This study also underlines the importance of teacher readiness and infrastructure in implementing digital learning media (Anwar, 2022). Teacher training in using applications is the key to the successful implementation of technology-based learning (Fitriani, 2021).

Parental involvement in the learning process is also an important factor. In this study, parents of students in the experimental group were given a guide to using the application so that they could accompany their children while studying at home (Hidayatullah, 2020). Support for a learning environment at home strengthens the effectiveness of digital learning media, especially for early childhood who still need intensive guidance (Marlina, 2019). Therefore, collaboration between teachers, students, and parents is the main pillar in improving learning outcomes (Zahra, 2020).

Technically, the educational game used in this study was designed with a simple algorithm to automatically adjust the difficulty level of the questions based on student performance (Santosa, 2021). This helps children feel challenged without feeling overwhelmed (Yuliani, 2022). In addition, the visual and audio aspects of the game are made interesting by using cartoon characters, narrator voices, and interactive animations (Firmansyah, 2020). These elements have been shown to be effective in maintaining the attention of early childhood (Setyaningsih, 2021).

In terms of measuring effectiveness, this study relies on the increase in posttest scores as the main indicator (Sukarman, 2020). However, observations of learning behavior were also used to support quantitative findings (Dewi, 2022). The researcher observed that students in the experimental group asked questions more often, tried questions again, and showed happy expressions when they answered correctly (Wijaya, 2021). These indicators show that educational games have succeeded in triggering students' intrinsic motivation (Hamdani, 2020).

The results of this study can be used as a basis for developing a technology-based curriculum at the elementary education level (Nurhayati, 2021). Considering the needs of the 21st century, the integration of technology in the reading learning process is a must (Lubis, 2022). This finding also opens up opportunities for educational application developers to create child-friendly products that are in line with national learning achievements (Ismail, 2021). Collaboration between educators and application developers is essential (Rahmadani, 2020).

As a follow-up, this study recommends the development of teacher training programs to effectively integrate digital media in reading learning (Kurniasih, 2021). In addition, further research is needed to see the long-term effects of using AI-based media (Solehah, 2022). Early reading learning using AI-based educational games has a significant positive impact on the learning achievement of first grade elementary school students (Hidayati, 2021). This innovation needs to be continuously developed and adjusted to technological developments and the needs of students (Wahyu, 2022).

Discussion

The results of the study showed that the use of educational games based on Artificial Intelligence (AI) had a significant impact on improving the reading skills of first-grade students of SD Taruna Mandiri Tangerang (Astutik, 2023). This can be seen from the difference in

pretest and posttest scores which were higher in the experimental group than in the control group, as well as the t-test results which showed a significance value below 0.05 (NI Putri et al., 2024) . Thus, it can be concluded that the use of AI-based interactive learning media has a real positive contribution to early reading learning (Dini, 2023) .

The significant increase in scores in the experimental group was due to several factors (Annisa, 2023) . First, the characteristics of AI-based educational games that present materials in an interesting, interactive, and tailored to user abilities make students more focused and motivated in learning (Prasetyo, 2021). AI in games allows for adaptive delivery of materials, namely adjusting the level of difficulty of the questions to the individual abilities of students. This is very important in the early stages of reading learning, because students have different levels of understanding and learning speeds.

Second, game -based learning has generally been proven to increase children's active participation and interest in learning (Sari, 2023). In this context, students feel like they are learning like playing, so that the learning process becomes fun and not relaxed (Inzani, 2019) . In addition, the sound, animation, and direct feedback features in the game also strengthen students' understanding of letters, syllables, and simple words (Prasetyo, 2021).

Third, AI-based media also helps teachers in integrating individual student development (Rizkia Puspitasari, 2022) . The AI system automatically records student learning outcomes and provides development analysis that teachers can use to design further interventions (Mawarni et al., 2022) . This is certainly difficult to do if teachers only use lecture methods or reading together in a classical manner (Fadilah & Rozie, 2024) .

On the other hand, although the control group also experienced an increase in learning outcomes, the increase was not as large as the experimental group (Tatmikowati, 2022) . This shows that conventional methods such as reading together on the board or practicing copying words, although still relevant, are less than optimal in adapting to the learning needs of 21st century students who are familiar with digital technology (Paidia et al., 2024) .

The results of this study are in line with various previous studies showing that the use of AI-based technology in basic education can improve the effectiveness of learning, especially in the literacy aspect (Mustajab et al., 2024) . This study also strengthens the importance of digital-based learning media innovation to improve the quality of education, especially in the current era of digital transformation (Okatavia et al., 2024) .

However, it should be noted that the effectiveness of AI-based media also depends heavily on the role of teachers in assisting, motivating, and directing students during the learning process (Hanifah, 2023) . Technology is only a tool; the end result still depends on how teachers integrate it appropriately into the teaching and learning process (Rahayu & Dafit, 2024) . Early reading learning through AI-based educational games is a relevant, effective, and adaptive approach to addressing the challenge of low early literacy in students, especially at the elementary school level (Brin, 2024) . This approach can be used as a model for learning innovation in other schools that have similar problems (Kurnia Dewi et al., 2023) .

The use of educational games based on Artificial Intelligence (AI) enables personalized and adaptive learning for each student (Nugroho & Kurniawan, 2023). This adaptability is important to adjust learning to the speed and abilities of each student, especially in the early stages of reading (Rahman & Lestari, 2022).

AI is able to identify student errors in real-time and provide specific direct feedback, so that students can learn from their mistakes independently (Susanti, 2023). This increases the effectiveness of learning and accelerates the understanding of basic reading concepts (Fitriani & Jannah, 2024). Interactivity in AI-based games makes the learning process more enjoyable, which has a positive impact on student learning engagement (Ardiansyah, 2023). High engagement has been shown to be closely related to better learning outcomes (Saputra & Nurhayati, 2022).

Animation, narration voice, and interesting illustrations in the game also support the dominant visual-auditory learning style in early childhood students (Putri & Setiawan, 2023). This makes it easier for students to understand and remember the material being studied (Nabila et al., 2024). From a psychological perspective, the educational game approach reduces anxiety and stress when learning to read because children feel like they are playing, not taking a test or learning assignment (Fauziah & Sari, 2023). This sense of comfort is an important foundation in building early literacy foundations (Kusumawati, 2022).

AI-based educational games also provide a comprehensive reporting system for teachers (Handayani & Mufidah, 2022). Teachers can monitor students' progress individually and identify which parts of the material students have not mastered (Yuliana et al., 2024). This is certainly different from conventional methods which are more difficult to measure learning performance objectively and continuously (Fitria & Haris, 2023). These advantages make digital media a very potential tool in basic literacy learning (NA Putri & Andini, 2024).

In this study, significant results in the experimental group were also inseparable from the intensity of the use of AI media which was carried out in a structured and consistent manner for four weeks (Astutik, 2023). Consistency in media use has been shown to influence its effectiveness in learning (Prasetyo & Hanifah, 2023). On the other hand, improvements in the control group were more limited due to the limitations of conventional methods which are one-way and do not include aspects of visual and interactive stimulation (Tatmikowati, 2022). Students tend to be passive and easily lose focus when learning with traditional methods (Yusuf & Aminah, 2023).

Several previous studies have also revealed that early childhood really needs learning that integrates elements of play so that they do not feel burdened (Sari & Widodo, 2024). This is why the game-based approach is very relevant in basic education (Rahmawati, 2023). The implementation of AI in reading learning is also considered in line with the direction of 21st century education policy which emphasizes technology integration, personalization of learning, and strengthening basic literacy (OECD, 2023). Therefore, the adoption of learning technology like this has become a necessity (Mulyani et al., 2024).

However, not all schools can immediately adopt AI-based educational games due to limited technological infrastructure and teacher competency in the digital field (Hidayah & Rohman, 2023). Therefore, training and support from educational institutions are very important (Rochmat & Fajar, 2024). The effectiveness of learning through digital media such as AI is also influenced by parental involvement at home (Rachmawati & Subekti, 2023). When children get parental support in using applications, their learning outcomes will be much more optimal (Zahra & Anwar, 2022).

Given these significant benefits, it is highly recommended that schools start considering implementing technology-based learning, especially to strengthen basic literacy (NI Putri et

al., 2024). However, its implementation must be adjusted to the readiness of resources and student conditions (Dini, 2023). This approach is also considered relevant to the characteristics of the digital native generation who are accustomed to electronic devices from an early age (Nasution & Liana, 2024). Educational games are a bridge between the world of children's play and formal education goals (KW Pratama, 2023).

In the context of reading learning, AI technology is not only a tool but also a facilitator to accommodate various learning styles of students (Halimah et al., 2023). This is important in creating an inclusive learning system that does not limit children's potential (Wulandari & Sari, 2024). Therefore, this study suggests that teachers and technology developers can collaborate in creating digital learning content that is child-friendly and in accordance with the curriculum (Febrianti et al., 2023). The content developed must also consider local cultural values and the social context of students (Kamilah & Widodo, 2023).

From the perspective of learning evaluation, the use of AI also opens up opportunities for the implementation of data-based assessments automatically and measurably (Rahmat & Gunawan, 2024). Such a system is very useful in making evidence-based learning decisions (evidence-based practice) (Sulastri et al., 2024). Overall, the results of this study not only show the success of AI-based educational games in improving early reading skills but also prove that technology integration in learning is an urgent need in this digital era (Astutik, 2023). Digital transformation in elementary education is no longer an option, but a necessity to create meaningful and adaptive learning (Okatavia et al., 2024).

CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the implementation of educational games based on Artificial Intelligence (AI) has a significant influence in improving the initial reading ability of first grade students of SD Taruna Mandiri Tangerang. Students who use AI-based educational games show a higher increase in initial reading ability compared to students who follow conventional learning.

The implementation of AI-based educational games has a significant effect on improving the initial reading skills of first grade students at Taruna Mandiri Elementary School, Tangerang, as evidenced by the higher increase in scores in the experimental group compared to the control group.

AI-based educational games provide interactive, adaptive, and fun learning, tailored to each student's abilities, thereby increasing motivation and participation in the learning process. The use of technology in learning, especially AI-based educational games, can be an innovative solution to address low initial reading skills in elementary schools, and can be applied in other schools to improve the quality of education.

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