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Development of Contextual Math-Edutainment: The Interactive "Geomath" Game to Enhance Seventh-Grade Junior High School Students' Understanding of Geometry

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Abstrak

Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi media pembelajaran berbasis permainan kontekstual yang dinamakan Geomaster, *yang dirancang untuk meningkatkan pemahaman konsep geometri pada siswa kelas VII. Penelitian ini menggunakan model pengembangan ADDIE yang terdiri dari lima tahap sistematis: analisis, desain, pengembangan, implementasi, dan evaluasi. Produk yang dikembangkan divalidasi oleh enam ahli—tiga ahli media dan tiga ahli materi pelajaran—dengan hasil penilaian rata-rata sebesar 91% dan 95%, yang menunjukkan bahwa media tersebut sangat layak untuk digunakan. Uji coba produk dilakukan dalam tiga tahap: uji coba skala kecil, skala besar, dan implementasi. Hasil uji coba skala kecil menunjukkan respons positif dari siswa (93%) dan guru (91,3%) terkait keterbacaan, kejelasan, dan daya tarik media. Pada uji coba skala besar, respons siswa mencapai rata-rata 89,8%, sedangkan respons guru sebesar 90,25%, yang semakin menegaskan efektivitas media. Selain itu, uji coba implementasi menunjukkan bahwa media mendukung berbagai aktivitas belajar siswa dengan nilai rata-rata 80,3% dan menghasilkan skor N-gain tinggi sebesar 0,72, yang mencerminkan peningkatan signifikan dalam hasil belajar. Penelitian ini menyimpulkan bahwa* Geomaster *secara efektif meningkatkan pemahaman konsep, meningkatkan keterlibatan siswa, serta mendukung integrasi media digital interaktif dalam pembelajaran geometri. Penelitian ini memberikan kontribusi terhadap literatur yang berkembang tentang gamifikasi dalam pendidikan matematika dan menekankan pentingnya pengembangan media pembelajaran inovatif untuk menjawab tuntutan pembelajaran abad ke-21.*

Abstract

This study aims to develop and evaluate a contextual game-based learning media called Geomaster, designed to enhance seventh-grade students' understanding of geometry concepts. Employing the ADDIE development model, the research followed systematic stages including analysis, design, development, implementation, and evaluation. The product was validated by six experts—three media experts and three subject matter experts—yielding an average feasibility rating of 91% and 95% respectively, indicating that the media was highly feasible for use. The trial phase was conducted in three stages: small-scale, large-scale, and implementation trials. Results from small-scale trials demonstrated positive feedback from both students (93%) and teachers (91.3%) regarding media readability, clarity, and motivational impact. In large-scale trials, student responses averaged 89.8%, and teacher responses averaged 90.25%, reinforcing the media's effectiveness. Furthermore, implementation trials indicated that the media supported various student learning activities with an average rating of 80.3% and achieved a high N-gain score of 0.72, reflecting significant improvement in learning outcomes. The study concludes that Geomaster effectively enhances conceptual understanding, fosters engagement, and supports the integration of interactive digital media in geometry instruction. This research contributes to the growing body of literature advocating for gamification in mathematics education and highlights the importance of developing innovative learning media to meet the demands of 21st-century learners.

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INTRODUCTION

Mathematical ability, particularly the understanding of geometric concepts, is a crucial aspect of primary education that significantly determines students' readiness to face both advanced educational challenges and everyday life. A solid understanding of geometry not only supports academic achievement in mathematics but also plays a key role in the development of logical, analytical, and visual thinking skills. However, various research findings have indicated that students' comprehension of geometry in Indonesia—particularly at the junior secondary level—remains far below expectations (Kurniawan, 2020). This issue has become a critical concern, considering the essential role of geometry in the mathematics curriculum and its relevance to real-life contexts.

Reports from the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) reinforce this concern, highlighting that Indonesian students consistently perform below the international average, especially in the domain of geometry (Puspendik, 2018). These data reveal a significant challenge in mathematics education in Indonesia, where students exhibit considerable difficulties in understanding and applying geometric concepts. The low achievement scores point to underlying problems in the instructional approaches and teaching methods employed in schools.

One of the primary causes of students' limited understanding of geometry is the dominance of conventional, less interactive teaching methods. Instruction that relies heavily on lectures and routine exercises tends to position students as passive recipients of information, without active engagement in contextual and applied learning processes (Rohendi & Dwijanto, 2017). Such methods often fail to accommodate the diverse learning needs of students, particularly those who benefit from more visual and practical approaches. As a result, many students lose interest and motivation, which negatively impacts their comprehension of geometry.

If this situation remains unaddressed, it may lead to students' continued inability to critically and creatively understand and apply geometric concepts. This will not only hinder their academic performance in mathematics but also impair their problem-solving skills in daily life situations that require geometric reasoning (Wijaya & Kusumah, 2019). These limitations also risk widening the educational gap between Indonesian students and their counterparts in countries with more advanced education systems, particularly in terms of mathematical competence.

To address this issue, the proposed solution involves the development of game-based educational media that presents geometric concepts within a more relevant and engaging context for students. This approach is grounded in the understanding that contextual and interactive learning can enhance student engagement and deepen their comprehension of the subject matter. Geomaster games are selected due to their strong potential to foster student involvement in the learning process and to support deeper understanding through active simulation and interaction (Nugroho & Wibowo, 2018). Moreover, this approach aligns with the rapid advancements in information and communication technology. The integration of learning and entertainment in a more engaging and accessible format represents a strategic response to the educational challenges of the digital era (Kurniawan, 2020). The use of educational games is expected to offer students a more enjoyable and contextual learning experience, enabling not only conceptual understanding but also the application of knowledge in real-life situations.

This study is significant as educational games have been shown to enhance not only students' motivation but also their critical and creative thinking skills—competencies that are essential in the globalized world (Rohendi & Dwijanto, 2017). These skills are increasingly vital in a complex and ever-changing environment where the ability to think innovatively and solve complex problems is highly demanded. By employing a contextual approach within the game, students are anticipated to better relate geometric concepts to real-life scenarios encountered in their daily lives. The ability to apply geometric knowledge in everyday contexts is crucial not only in academic settings but also in fostering higher-order thinking skills necessary to meet future challenges. Therefore, this study contributes to the development of innovative and adaptive teaching methods that cater to the needs of students in the digital age. Consequently, the findings

are expected to offer effective solutions for enhancing the quality of mathematics education in Indonesia, particularly in the domain of geometry (Wijaya & Kusumah, 2019).

This research highlights the novelty of the contextual application approach utilized in the Math-Edutainment game for geometry instruction—an area that has received limited exploration in prior studies. For instance, Wijaya and Kusumah (2019) focused on the development of educational games to improve problem-solving skills but did not explicitly link geometric concepts to real-world contexts. Nugroho and Wibowo (2018) emphasized the development of games for fostering creative thinking but did not address their relevance to real-life situations. Similarly, Kurniawan (2020) investigated realistic approaches in geometry learning but did not employ interactive digital media such as games. Rohendi and Dwijanto (2017) developed interactive media for geometry education, yet their work was limited to computer-based applications lacking strong contextual integration. Lastly, Suparman (2021) explored the use of mobile applications for mathematics education, focusing more on arithmetic than geometry. The novelty of this research lies in the integration of game-based technology with a contextual approach, which facilitates students' understanding and real-life application of geometric concepts, thereby making a significant contribution to the development of interactive learning methods in the digital era.

The research employs a Research and Development (R&D) approach, aimed at producing a Geomaster game as an educational product. This methodology is selected because R&D not only allows for the theoretical exploration of concepts but also enables their practical implementation in the form of tangible products that can be directly applied in educational settings. As suggested by Nugroho and Wibowo (2018), the R&D approach is effective in developing instructional media tailored to students' needs, particularly in a modern educational context that increasingly relies on technological integration. Furthermore, this approach allows for the direct testing of the developed game in real classroom settings, offering valuable feedback for subsequent refinements (Rohendi & Dwijanto, 2017). The primary objective of this study is to enhance seventh-grade students' understanding of geometry through interactive and contextual learning media. By adopting a contextual approach, students are expected to connect geometric concepts with real-life situations, thereby improving their motivation and comprehension of the subject matter (Suparman, 2021).

METHOD

The present study employed a Research and Development (R&D) approach with the primary objective of developing an innovative educational product in the form of a smartphone-based educational game, titled *Math-Edutainment Kontekstual*. The R&D model utilized in this study was adapted from the development framework proposed by Borg and Gall (1983), which has been extensively applied in educational research to design and assess the effectiveness of instructional products (Sugiyono, 2016). The development model comprises several critical stages, namely: needs analysis, product design, product development, product testing, product revision, implementation testing, and dissemination.

Needs Analysis.

This stage involved identifying instructional problems and student learning needs related to geometry instruction in Grade VII of junior high school. Data were collected through classroom observations, interviews with teachers, and document analysis of student learning outcomes (Kurniawan, 2020). The analysis revealed that geometry instruction predominantly relied on conventional teaching methods, which lacked active student engagement.

Product Design.

Based on the identified needs, an initial design for the *Math-Edutainment Kontekstual* game was developed. The design included the development of curriculum-aligned geometry content and the integration of interactive game elements to enhance students' conceptual understanding (Nugroho & Wibowo, 2018).

Product Development

In this phase, the game was constructed according to the established design. The development process involved creating geometry content packaged in an educational game format and conducting internal testing by the development team to ensure the game functioned in line with the original design specifications.

Product Testing

The developed game was subjected to both small-scale and large-scale trials. The small-scale trial involved 10 Grade VII students to gather initial feedback, while the large-scale trial included 30 Grade VII students to evaluate the game's effectiveness in improving geometry comprehension. Data were collected through questionnaires, observation sheets, and pre- and post-tests (Rohendi & Dwijanto, 2017).

Product Revision

Based on the results of the testing phase, the game underwent revisions to address identified weaknesses. Revisions included adjustments to the content and features of the game to better support the learning objectives in geometry.

Implementation Testing

The revised product was then implemented in broader classroom settings to evaluate its sustainability. This stage included analyzing student learning outcomes before and after using the game to determine the significant impact of the game on geometry learning (Wijaya & Kusumah, 2019).

Implementation and Dissemination

After completing all development and evaluation stages, the finalized game was fully integrated into the classroom learning process. The outcomes of the research were disseminated through academic publications and educational seminars to contribute to the advancement of innovative instructional practices in Indonesia (Puspendik, 2018).

The study was conducted at a public junior high school in Indonesia during the 2023/2024 academic year. Research subjects consisted of Grade VII students divided into two groups: a small-scale trial group and a large-scale trial group. The small-scale group included 10 purposively selected students from Class VII-A, representing diverse levels of understanding of geometry concepts. The large-scale trial involved 30 randomly selected students from Class VII-B, chosen from the Grade VII student population. This sampling strategy aimed to provide a representative evaluation of the effectiveness of the *Math-Edutainment Kontekstual* game in enhancing students' geometry comprehension (Setiawan & Prasetyo, 2021).

Data collection in this study was carried out using multiple methods, including documentation, questionnaires, observation sheets, and tests. The following are the data collection procedures implemented:

Documentation. Initial data were gathered through documentation techniques, which involved collecting curriculum documents, syllabi, lesson plans (RPP), and students' learning outcomes in geometry prior to the implementation of the game. These documents served as references for designing the game content and as baseline data for comparing the effectiveness of the game after its application (Arikunto, 2019).

Questionnaires. Questionnaires were utilized to collect feedback from both students and teachers regarding the developed game. In the small-scale trial, a readability questionnaire was distributed to students to assess their understanding of the game's instructions and content. In the large-scale trial, a usability questionnaire was used to evaluate the practicality and appeal of the game from the students' perspective. Additionally, a teacher response questionnaire was administered to gather pedagogical feedback (Nursyahidah, 2020).

Observation Sheets. Observations were conducted during the learning process to monitor student activities while using the game. Observation sheets were employed to record students'

interactions with the game, levels of participation, and responses to the challenges presented. These observational data were essential for evaluating the extent to which the game engaged students in the learning process (Fathurrahman & Mulyati, 2020).

Pre-Test and Post-Test. A pre-test was administered to students before the implementation of the game to measure their initial understanding of the geometry material. Following the implementation, a post-test was conducted to assess the improvement in students' comprehension. The results of the pre-test and post-test were analyzed using the N-gain calculation to determine the effectiveness of the game in enhancing students' understanding of geometry (Hake, 1999; Widjaja & Kusumah, 2019).

The data analysis technique employed in this study was the Normalized Gain (N-gain) analysis, a quantitative method used to measure the effectiveness of instructional interventions by comparing students' pre-test and post-test scores. N-gain is calculated using the formula

$$N\text{-}gain = (post\text{-}test - pre\text{-}test) / (100 - pre\text{-}test),$$

which yields a value ranging from 0 to 1. These values are then classified into low (≤0.3), medium (0.3–0.7), and high (>0.7) categories to assess the level of learning improvement. This technique enables researchers to determine the extent to which the developed instructional media contributes to enhancing students' understanding of the subject matter. In addition, classical completeness analysis was used to evaluate the proportion of students who achieved scores above the Minimum Mastery Criteria (KKM), which in this context serves as an indicator of the media's effectiveness in improving overall academic performance. The application of both N-gain and classical completeness analysis is well-established in studies examining the effectiveness of instructional media and learning models (Hake, 1998; Meltzer, 2002; Rusilowati et al., 2016; Widodo & Wahyudin, 2018; Huda et al., 2020), and has proven to be relevant for evaluating learning outcomes comprehensively. With an N-gain score of 0.72 (categorized as high) and a significant increase in classical completeness, it can be concluded that the instructional media developed in this study was effective in improving students' learning outcomes.

RESULT AND DISCUSSION

Result

This study involved 40 seventh-grade students from a public junior high school in Indonesia as respondents. These respondents were divided into two main groups: 10 students who participated in the small-scale trial and 30 others who took part in the large-scale trial. Respondents for the small-scale trial were selected using purposive sampling, while random sampling was employed for the large-scale trial, ensuring sufficient variation in their levels of understanding of geometry concepts. The development of the educational game-based learning media *"Geomaster"* followed the Borg and Gall development model, which comprises several key stages: needs analysis, product design, product development, product testing, product revision, implementation trial, and full implementation and dissemination.

Needs Analysis. The initial stage was the Needs Analysis, during which the researcher conducted direct classroom observations and interviews with teachers to identify problems in geometry instruction. Based on the observations, it was found that the conventional teaching methods in use—dominated by lectures and drill exercises—were ineffective in helping students grasp the abstract concepts of geometry. Student achievement data revealed that their average scores in geometry were below the expected standard, indicating significant difficulties in understanding the material.

Figure 1. Homepage of Geomaster

Figure 1 illustrates the design results of the video game, which is playable on Android devices. The game was designed based on the results of the students' needs analysis, presented in an engaging manner with cartoon illustrations and a visual appearance tailored to students' preferences.

Product Design. The next stage was the Product Design. The *"Geomaster"* educational game was designed with input from teachers and education experts. The game design included several key elements, such as geometry content aligned with the curriculum, visualization of concepts through engaging graphics, and interactive features that allowed students to actively participate in learning. The game was also designed for both individual and small-group use, aiming to facilitate students' comprehension of difficult concepts through enjoyable and challenging activities.

Figure 2. Menu and Learning Interface in Geomaster

Product Development. The next stage was Product Development, in which the prototype of the *"Geomaster"* game was developed based on the previously formulated design. This prototype incorporated all key planned features, such as interactive quizzes, geometry simulations, and an evaluation system that provides real-time feedback to students.

Table 1. Expert Evaluation Results

No	Expert Category	Expert	Average Score	Criteria
1	Media Expert	Expert 1	91%	Highly Feasible
		Expert 2	90%	
		Expert 3	92%	
2	Subject Expert	Expert 1	95%	Highly Feasible
		Expert 2	94%	
		Expert 3	96%	

Table 1 presents the expert evaluations of the developed product. Based on assessments from three media experts, the average score obtained was 91%, classified as "Highly Feasible." Subject experts also gave highly positive evaluations, with an average score of 95%. These results indicate that the developed product meets high standards in terms of both media and content quality and is highly suitable for use as a learning medium. This evaluation serves as the basis for proceeding to the trial phase.

Product Trials. Product trials were conducted in two stages: small-scale and large-scale. Small-Scale Trial In this stage, 10 students were selected to test the game in a controlled learning environment. Feedback from students and teachers was collected through questionnaires and interviews to evaluate the game's readability, practicality, and attractiveness. The results indicated that students found the game highly engaging and helpful in understanding challenging geometry concepts. However, there were some concerns regarding navigation difficulties and the perceived difficulty of certain questions.

Table 2. Student Feedback on Readability

No	Aspect	Percentage	Criteria
1	Engaging media	97%	Very Good
2	Clear images	93%	Very Good
3	Clear font type and size	91%	Very Good
4	Easy-to-understand sentences	89%	Very Good
5	Media motivates learning	95%	Very Good
	Average	**93%**	**Very Good**

Table 2 summarizes students' feedback on the readability of the tested media. Overall, the feedback showed that the media was rated as "Very Good" by students, with an average percentage of 93%. Aspects such as image clarity, font readability, and the media's ability to motivate learning received very good ratings. This indicates that the developed media was well-designed, easy to understand, and appealing to students—critical factors for effective learning.

Table 3. Teacher Feedback on Game Readability

No	Aspect	Teacher 1	Teacher 2	Average	Criteria
1	Engaging media	90%	85%	87.5%	Very Good
2	Clear images	95%	95%	95%	Very Good
3	Clear font type and size	85%	90%	87.5%	Very Good
4	Easy-to-understand sentences	92%	88%	90%	Very Good
5	Media motivates learning	93%	90%	91.5%	Very Good
	Average			**91.3%**	**Very Good**

Table 3 presents teacher feedback on the readability of the tested media. The average percentage given by teachers was 91.3%, also categorized as "Very Good." Teachers gave positive assessments of the media's clarity, font readability, and its ability to motivate students to learn. This confirms that the developed media was not only well-received by students but also by teachers, who play a vital role in the instructional process.

Large-Scale Trial. After revisions based on the feedback from the small-scale trial, the game was re-tested with 30 students. The purpose of the large-scale trial was to evaluate the game's effectiveness in improving students' overall understanding. The results showed a significant increase in students' post-test average scores compared to their pre-test scores, indicating that the game effectively supported students in understanding geometry concepts.

Table 4. Students' Responses in Large-Scale Trial of the Game

No	Aspect	Percentage	Criteria
1	Interesting media	92%	Very Good
2	Clear images	91%	Very Good
3	Easily understood sentences	89%	Very Good
4	Motivating learning media	87%	Very Good
	Average	**89.8%**	**Very Good**

Table 4 shows the students' responses in the large-scale trial. The developed learning media received an average score of 89.8%, indicating that students rated it as very good. Aspects such as sentence clarity, ease of understanding, and the media's ability to motivate learning received high ratings. This suggests that the media is widely accepted among a large number of students and is effective in supporting the learning process.

Table 5. Teachers' Responses in Large-Scale Trial

No	Aspect	Teacher 1	Teacher 2	Average	Criteria
1	Interesting media	92%	88%	90%	Very Good
2	Clear images	91%	89%	90%	Very Good
3	Easily understood sentences	87%	92%	89.5%	Very Good
4	Motivating learning media	90%	93%	91.5%	Very Good
	Average			**90.25%**	**Very Good**

Table 5 illustrates teachers' responses in the large-scale trial of the developed learning media. With an average score of 90.25%, the teachers' responses were highly positive, indicating that the media is not only attractive and clear but also aligns with the intended learning objectives. Teachers assessed that this media effectively enhances student motivation and aids in comprehending the learning material. This evaluation is particularly important as teachers are the primary users of the media in daily learning activities.

Product Revision. The next stage is Product Revision. Based on feedback from the large-scale trial, the researchers revised the product to address remaining weaknesses, such as adjusting question difficulty levels, improving the user interface, and enhancing the feedback system.

Implementation Trial. The Implementation Trial stage involved full integration of the game into the seventh-grade geometry learning process. This trial lasted several weeks and included all students in the class. The results showed a significant improvement in students' understanding of geometric concepts.

Table 6. Student Learning Activity Assessment Results

No	Criteria	Percentage	Rating
1	Visual activities	75%	Good
2	Oral activities	80%	Good
3	Listening activities	78%	Good
4	Writing activities	77%	Good
5	Motor activities	84%	Very Good
6	Mental activities	83%	Very Good
7	Emotional activities	85%	Very Good
	Average	**80.3%**	**Good**

Table 6 presents the assessment results of students' learning activities during the use of the developed media. The average percentage obtained was 80.3%, which falls into the "Good" category. Visual, oral, listening, writing, motor, mental, and emotional activities were rated good

to very good. This indicates that the developed learning media effectively supports various types of student learning activities, which is an essential indicator of the media's success in creating a holistic and effective learning environment.

Implementation and Dissemination. The final stage is Implementation and Dissemination. After going through various development and testing stages, the "Geomaster" game was fully implemented in the schools involved in the study. The implementation results show that the game was well received by both students and teachers and was effective in improving students' geometry learning outcomes.

Table 7. N-Gain Test Results

Data	**Class VIII C**	
Pre-test	Pre-test	Post-test
Number of Students	30	30
Highest Score	75	88
Lowest Score	35	55
Average Score	56.67	86.33
Number of Students Passed	0	25
Number of Students Not Passed	30	5
Classical Mastery	0%	83.33%
Gain Score	0.72 (High)	

Table 7 displays the N-gain test results, used to measure the improvement in student learning outcomes before and after using the developed learning media. The results indicate that the average student score increased from 56.67 on the pre-test to 86.33 on the post-test, with a gain score of 0.72, categorized as high. Additionally, classical mastery improved from 0% on the pre-test to 83.33% on the post-test. These findings indicate that the developed media is highly effective in enhancing students' understanding of the taught material.

From the development and implementation results of the "Geomaster" game, it can be concluded that this game is highly effective in improving students' understanding of geometric concepts. It successfully captures students' interest, increases their engagement in the learning process, and helps teachers deliver difficult material in a more engaging and comprehensible way. Thus, this game can be an effective solution for improving the quality of geometry education in Indonesia, especially in addressing the challenges of learning in the digital era.

Discussion

The development of contextual Math-Edutainment learning media for improving geometric concept understanding in seventh-grade students has yielded significant findings, emphasizing the importance of integrating game-based approaches and interactive elements in educational tools. The effectiveness of this media lies in its ability to provide a dynamic and engaging learning environment, which significantly enhances students' motivation and involvement in the learning process. This is consistent with research by Sari et al. (2020), which found that interactive learning media, particularly those based on animation, significantly boosts student engagement and learning outcomes. The use of animations and audiovisual elements has long been recognized as a key factor in enhancing the appeal of learning materials (Kurniawan, 2020). In this context, the development of the Math-Edutainment media was designed to align with students' preferences, using cartoon illustrations and color compositions that cater to the learning styles of young learners. Such multimedia strategies are essential in providing a more engaging and motivating learning experience, as demonstrated by previous studies (Sari et al., 2020; Rahmi, 2022).

One of the main objectives of the study was to create a learning media that not only enhances understanding but also motivates students to engage actively in the learning process. The findings from the current research show that the Math-Edutainment media achieved this

objective, as it facilitated a substantial improvement in students' geometric concept understanding. According to Supriyanto (2021), digital-based learning media that foster interactivity are key to enhancing student engagement and critical thinking. The incorporation of game elements, such as problem-solving activities and interactive challenges, in this research is a significant contribution to the existing body of knowledge, particularly because it addresses the gap in previous studies that lacked such integration. For instance, the study by Wulandari and Prasetyo (2019) highlighted the importance of technology in learning media but did not explore the full potential of game-based approaches, which are now recognized for their effectiveness in promoting deeper cognitive engagement among students (Hassan et al., 2021).

In comparing the current study with the works of Wulandari and Prasetyo (2019), it is evident that the introduction of game elements into learning media has proven to be highly beneficial for student engagement and learning outcomes. While Wulandari and Prasetyo's research emphasized technological integration through digital tools, their media relied heavily on static text and images, which limited the interactivity and appeal of the content (Wulandari & Prasetyo, 2019). Conversely, the Math-Edutainment media incorporated game-based learning features, offering a more immersive and dynamic learning experience. According to Susanto (2020), incorporating interactive elements such as games within learning media has been shown to promote better retention of information and foster critical thinking skills. Game-based learning, as a pedagogical strategy, has been linked to increased student motivation, which is a crucial factor in enhancing learning outcomes (Harahap et al., 2022).

The results of this study also indicate that the Math-Edutainment media can effectively motivate students to engage with geometric concepts in a more meaningful way. This finding is in line with the work of Rahmi (2022), who demonstrated that game-based learning not only motivates students but also encourages them to develop problem-solving skills. The research further revealed that the students' active participation in the game-based learning activities significantly improved their understanding of geometric principles. This outcome is consistent with the findings of several other studies, which highlight the potential of game-based learning to facilitate the acquisition of complex concepts in subjects such as mathematics (Nurfadilah & Rahman, 2020). Game elements serve as a bridge between theoretical knowledge and practical application, allowing students to explore mathematical concepts in a fun and interactive environment, thereby enhancing their conceptual understanding.

Moreover, the study's implementation of the ADDIE model in developing the learning media has contributed significantly to its effectiveness. The ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation, is a well-established framework for creating educational content that is systematic and structured (Yuliawan et al., 2021). The model's emphasis on iterative testing and feedback allowed the researchers to refine the media based on students' and teachers' responses, ensuring that the final product was both engaging and pedagogically sound. The flexibility and clear stages of the ADDIE model enabled the researchers to fine-tune the media based on real-time feedback, ultimately optimizing the media's effectiveness. This structured approach is in line with the findings of Yuliawan et al. (2021), who argued that the ADDIE model facilitates the creation of high-quality educational content by ensuring that each phase of development is carefully executed.

The incorporation of technology into the learning process, particularly through the use of game-based learning, has been widely recognized as an effective method for enhancing student learning. According to Simamora (2022), the integration of interactive digital media fosters creativity and critical thinking in students, allowing them to engage with content in ways that traditional methods may not support. The current study supports this view, as students reported increased engagement and a greater willingness to explore geometric concepts through the game-based media. The research also indicates that the interactive nature of the Math-Edutainment media promotes higher levels of cognitive engagement, which is essential for mastering complex mathematical concepts (Harahap et al., 2022).

Furthermore, the study highlighted the positive impact of game-based learning on students' creativity and problem-solving abilities. These findings are consistent with those of

several studies that have shown that gamification in education can foster creative thinking by encouraging students to approach problems from different perspectives (Hassan et al., 2021; Nurfadilah & Rahman, 2020). Game-based learning, with its challenges and interactive elements, not only enhances students' understanding of mathematical concepts but also nurtures their problem-solving skills, which are crucial for their overall cognitive development.

In conclusion, the results of this research demonstrate that Math-Edutainment, as a game-based learning media, significantly improves students' understanding of geometric concepts while fostering their motivation and engagement in the learning process. The integration of technology, particularly through game-based learning, has proven to be a highly effective strategy for enhancing student learning outcomes. This study contributes to the growing body of research on game-based learning and provides evidence of its potential in mathematics education. The findings support the idea that technology-enhanced, interactive learning environments not only improve students' academic performance but also foster the development of essential cognitive skills, such as creativity, problem-solving, and critical thinking. Further research should continue to explore the potential of game-based learning in various subjects and educational settings, particularly in countries like Indonesia, where the integration of technology in education is still evolving

The limitations of the current study must be acknowledged, as they provide insights into areas that could benefit from further investigation. First, while the Math-Edutainment media was effective in enhancing students' understanding of geometric concepts, the study was limited to a specific subject (geometry) within mathematics, and the results may not be directly transferable to other areas of mathematics or subjects outside of mathematics. Future research could explore the applicability of this media in different mathematical topics such as algebra, calculus, or statistics, as well as in other subject areas such as science or language arts. Research by Harahap et al. (2022) and Nurfadilah & Rahman (2020) suggests that game-based learning is effective across a range of disciplines, and expanding the scope of research could help determine whether the Math-Edutainment approach has broader applications.

Another limitation is the sample size and the context in which the research was conducted. The study was limited to a single class of seventh-grade students, which may not fully represent the diversity of students in different schools, regions, or educational systems. The findings might be influenced by the specific demographic characteristics of the participants, such as their level of prior knowledge, cultural background, or access to technology. Future studies could involve a larger and more diverse sample of students, including those from rural and urban areas, to assess whether the effectiveness of game-based learning media is consistent across different student populations (Susanto, 2020). Additionally, research could explore the effects of socioeconomic factors on students' engagement with and access to digital learning tools, especially in contexts where digital infrastructure is limited.

Furthermore, the current study relied heavily on self-reported data from students and teachers, which may be subject to biases. While the feedback provided valuable insights into the effectiveness of the Math-Edutainment media, further studies could incorporate more objective measures, such as standardized tests or observational data, to triangulate the findings. This would allow for a more comprehensive evaluation of the media's impact on learning outcomes (Simamora, 2022). Additionally, longitudinal studies could be conducted to assess the long-term impact of using game-based learning tools on students' academic performance and retention of mathematical concepts.

Moreover, while the study employed the ADDIE model in the development of the learning media, future research could explore the integration of other instructional design models or the combination of multiple models to enhance the media's effectiveness. For instance, models like SAM (Successive Approximation Model) or TPACK (Technological Pedagogical Content Knowledge) could provide alternative frameworks for developing and evaluating digital learning tools (Yuliawan et al., 2021). This could help refine the learning experience by incorporating more adaptive and responsive elements based on real-time student interactions.

In addition to these limitations, there are several opportunities for future research in the area of game-based learning and Math-Edutainment. One potential avenue for future research is

exploring the impact of gamification on different cognitive skills beyond understanding mathematical concepts. While this study focused on geometric concepts, future studies could investigate how game-based learning affects students' problem-solving abilities, critical thinking, and creativity in other subjects. Studies by Hassan et al. (2021) and Rahmi (2022) have shown that game-based learning can foster creative problem-solving, and further research could investigate how these skills transfer to real-world applications.

Another promising area for future research involves the use of adaptive learning technologies within game-based learning media. As students' needs and abilities vary widely, integrating adaptive learning technologies that personalize the learning experience could provide more targeted interventions, allowing the game-based media to better cater to individual students' strengths and weaknesses (Rahmi, 2022). This personalized approach could further enhance the effectiveness of the media, particularly for students who may need additional support in mastering certain concepts or skills.

Furthermore, future research could investigate the role of teacher training in the successful implementation of game-based learning media. While the current study demonstrated that the Math-Edutainment media was effective in the classroom, it is important to consider the teacher's role in facilitating the learning experience. Studies by Simamora (2022) and Yuliawan et al. (2021) emphasize the importance of teacher preparedness in integrating technology into the classroom. Future research could explore how teachers' familiarity with game-based learning tools, their comfort with using digital media, and their pedagogical strategies influence the success of game-based media in enhancing student learning outcomes.

Lastly, it would be valuable to explore the effects of collaborative and social learning elements within game-based learning environments. While the current study focused on individual learning outcomes, collaborative learning—such as group-based challenges or peer interactions—has been shown to promote deeper engagement and understanding (Harahap et al., 2022). Future research could examine how social interactions in game-based learning environments impact students' motivation and learning outcomes, particularly in subjects like mathematics, where collaborative problem-solving is essential.

In conclusion, while this study provides strong evidence of the effectiveness of Math-Edutainment media in improving students' geometric understanding, several opportunities for future research remain. Expanding the scope of the study to include a wider range of subjects, diverse student populations, and longitudinal measures of learning outcomes could help further validate the generalizability and long-term impact of game-based learning. Additionally, integrating adaptive learning technologies, teacher training, and collaborative learning features into the media could further enhance its effectiveness. By addressing these limitations and exploring new avenues for research, future studies can continue to refine and optimize game-based learning tools to better support students in their educational journey.

CONCLUSION

The development and implementation of the "Geomaster" game demonstrated significant effectiveness in enhancing students' understanding of geometric concepts. Expert evaluations indicated that both media and content quality were highly feasible, with scores of 91% and 95%, respectively, from media and subject experts. Product trials revealed that students and teachers rated the media as very good, with the game receiving positive feedback on its readability, clarity, and ability to motivate learning. The large-scale trial confirmed that the game significantly improved students' learning outcomes, as evidenced by the notable increase in post-test scores and high N-gain scores. The game successfully engaged students, supported various learning activities, and provided a dynamic learning experience, making it an effective tool for geometry education. These findings suggest that the integration of game-based learning can be a valuable strategy for improving student outcomes and engagement, particularly in the digital learning environment. However, further revisions and refinements based on feedback are essential to addressing specific areas of improvement such as question difficulty and user interface.

REFERENCES

Arikunto, S. (2019). *Prosedur Penelitian: Suatu Pendekatan Praktik (Revisi)*. Rineka Cipta.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., & Rumble, M. (2012). Defining twenty-first-century skills. In *Assessment and teaching of 21st century skills* (pp. 17-66). Springer.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.

Chen, C. M., & Huang, Y. M. (2020). The effects of using educational game to enhance students' learning performance in mathematics. *Educational Technology Research and Development*, 68(3), 939-958. https://doi.org/10.1007/s11423-020-09787-4

Fathurrahman, M., & Mulyati, E. (2020). Penggunaan Lembar Observasi dalam Pembelajaran Matematika. *Jurnal Ilmu Pendidikan*, 18(1), 67-78.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). Educational Research: An Introduction (8th ed.). Boston: Pearson.

Harahap, A. B., Nasution, D. R., & Manullang, M. (2022). Pengembangan Media Pembelajaran Matematika Berbasis Game untuk Meningkatkan Motivasi Belajar Siswa. *Jurnal Inovasi Pendidikan*, 10(1), 34-47.

Harahap, E., Sari, R. M., & Anwar, A. (2022). Gamification in education: Improving learning motivation in mathematics through game-based learning. *Journal of Educational Technology*, 17(3), 45-60. https://doi.org/10.1016/j.jedtech.2022.03.004

Hassan, A., Ahmad, S., & Lee, K. (2021). The role of game-based learning in enhancing problem-solving skills in mathematics. *Journal of Educational Psychology*, 93(4), 22-39. https://doi.org/10.1080/00220671.2021.1902357

Kurniawan, A. (2020). Pengembangan Media Pembelajaran Interaktif untuk Meningkatkan Pemahaman Siswa. *Jurnal Pendidikan Matematika*, 9(2), 112-125.

Kurniawan, M. (2020). Pengaruh Pendekatan Pembelajaran Matematika Realistik terhadap Kemampuan Pemecahan Masalah Geometri Siswa SMP. *Jurnal Pendidikan Matematika*, 14(2), 155-166.

Kurniawan, R. (2020). Pemahaman konsep geometri dalam pembelajaran matematika. *Jurnal Pendidikan Matematika*, 8(2), 135-147.

Kurniawan, R. (2020). Teknologi Pendidikan di Era Digital: Inovasi dan Tantangan. Bandung: Alfabeta.

Nugroho, A., & Wibowo, P. (2018). Pengembangan Media Pembelajaran Berbasis Game Edukasi untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa. *Jurnal Teknologi Pendidikan*, 20(1), 12-25.

Nugroho, A., & Wibowo, S. (2018). Efektivitas Penggunaan Game Edukasi dalam Pembelajaran Matematika. *Jurnal Teknologi Pendidikan*, 15(1), 45-58.

Nurfadilah, F., & Rahman, A. (2020). Pengaruh Media Pembelajaran Interaktif terhadap Peningkatan Hasil Belajar Matematika. *Jurnal Pendidikan Matematika*, 6(2), 89-102.

Nurfadilah, S., & Rahman, M. (2020). *The effectiveness of gamification in teaching geometry: A case study in secondary school classrooms*. Journal of Research in Mathematics Education, 30(1), 59-73. https://doi.org/10.1007/s40249-020-00317-w

Nursyahidah, A. (2020). Analisis Penggunaan Angket dalam Penelitian Pendidikan. *Jurnal Pendidikan*, 7(2), 104-112.

Puspendik. (2018). Laporan hasil PISA 2018: Prestasi siswa Indonesia dalam pendidikan matematika. *Pusat Penilaian Pendidikan*, Kemendikbud.

Rahmi, A. (2022). Penggunaan Media Digital dalam Meningkatkan Pemahaman dan Kreativitas Siswa. *Jurnal Teknologi Pembelajaran*, 8(3), 67-78.

Rahmi, R. (2022). Gamified learning in mathematics: How game-based learning enhances student engagement and academic achievement. *International Journal of Educational* Research, 15(2), 132-145. https://doi.org/10.1016/j.ijer.2021.07.009

Rohendi, D., & Dwijanto, A. (2017). Metode pembelajaran interaktif dalam pendidikan matematika. *Jurnal Pendidikan dan Kebudayaan*, 22(4), 457-465.

Rohendi, D., & Dwijanto, T. (2017). Pengaruh Penggunaan Media Interaktif Berbasis Komputer terhadap Pemahaman Konsep Geometri Siswa SMP*. Jurnal Pendidikan dan Pengajaran*, 50(3), 175-183.

Setiawan, A., & Prasetyo, W. (2021). Metode Sampling dalam Penelitian Pendidikan*. Jurnal Penelitian dan Pengabdian*, 8(2), 134-142.

Simamora, M. (2022). Interactive digital media as a tool for fostering creativity in mathematics problem-solving. *Journal of Creative Education*, 13(4), 201-218. https://doi.org/10.1207/jce.2022.13.4.201

Simamora, R. H. (2022). Pengaruh Media Digital Interaktif terhadap Kreativitas Siswa dalam Pembelajaran Matematika. *Jurnal Pendidikan Inovatif*, 12(1), 56-67.

Sugiyono. (2016). Metode Penelitian & Pengembangan (Research and Development). Alfabeta.

Suparman, M. (2021). Efektivitas Penggunaan Aplikasi Mobile dalam Pembelajaran Matematika di SMP*. Jurnal Inovasi Pendidikan*, 8(3), 113-122.

Suparman, U. (2021). Pengembangan Aplikasi Mobile untuk Pembelajaran Matematika pada Konsep Aritmatika. *Jurnal Inovasi Pendidikan*, 14(1), 45-57.

Supriyanto, B. (2021). Pengembangan Media Pembelajaran Digital Berbasis Video untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Teknologi Pembelajaran*, 9(1), 28-39.

Susanto, H. (2020). *The impact of socioeconomic factors on students' access to digital learning tools: Implications for educational equity*. International Journal of Education, 9(2), 114-130. https://doi.org/10.3389/ijed.2020.01934

ugroho, A., & Wibowo, A. (2018). Pengembangan game edukasi untuk meningkatkan motivasi belajar siswa. *Jurnal Teknologi Pendidikan*, 12(1), 22-31.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Widjaja, A., & Kusumah, Y. S. (2019). Perhitungan N-Gain dalam Pengukuran Efektivitas Pembelajaran. *Jurnal Pendidikan Matematika*, 13(1), 25-34.

Wijaya, A., & Kusumah, Y. (2019). Kesenjangan prestasi matematika di Indonesia: Analisis berdasarkan hasil TIMSS dan PISA. *Jurnal Penelitian dan Evaluasi Pendidikan*, 23(2), 210-223.

Wijaya, A., & Kusumah, Y. (2019). Penerapan Model Pembelajaran Kontekstual untuk Meningkatkan Pemahaman Geometri. *Jurnal Pendidikan dan Pembelajaran*, 12(3), 240-255.

Wijaya, T. T., & Kusumah, Y. S. (2019). Pengembangan Game Edukasi Matematika untuk Meningkatkan Kemampuan Pemecahan Masalah dan Pemahaman Konsep Geometri Siswa. *Jurnal Pendidikan Matematika*, 13(1), 30-43.

Wulandari, A., & Prasetyo, E. (2019). Technology-based learning media in mathematics education: Improving student learning outcomes through the integration of multimedia and interactive features. *Indonesian Journal of Educational Research*, 5(1), 45-58. https://doi.org/10.1080/ijed.2019.1507492

Wulandari, T., & Prasetyo, D. (2019). Penggunaan Teknologi dalam Pengembangan Media Pembelajaran untuk Meningkatkan Hasil Belajar Matematika. *Jurnal Teknologi Pendidikan*, 11(3), 88-101.

Yuliawan, D., Sari, S., & Purnama, F. (2021). *ADDIE model in the development of educational media for enhancing student learning outcomes in mathematics*. International Journal of Instruction, 14(3), 123-137. https://doi.org/10.29333/iji.2021.14313a

Yuliawan, R. P., Setiawan, B., & Nurhadi, D. (2021). Implementasi Model ADDIE dalam Pengembangan Media Pembelajaran untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Inovasi Pendidikan*, 14(2), 98-112.