AKSIOMA: Jurnal Program Studi Pendidikan Matematika
Volume 15, No. 1, 2026, 14-26

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

THE DEVELOPMENT OF AN ANDROID-BASED ETHNOMATHEMATICS PUZZLE GAME MEDIA ON FLAT-BUILT GEOMETRY MATERIAL

Hidayatulloh[1], Jonanes Sapri[2], Agus Susanta[3], Sudarwan Danim[4], Endang Widi Winarni[5]

[1]Universitas Muhamamdiyah Pringsewu - Lampung Indonesia
[2,3,4,5]Universitas Bengkulu – Bengkulu Indonesia
Corresponding author : hidayatulloh@umpri.ac.id

Received 20 January 2024; Revised 02 March 2025; Accepted 10 February 2026

Abstract

The low achievement in mathematics among students is a significant issue in education, primarily due to the lack of innovative and contextual learning media. Additionally, the limited use of technology as a learning aid reduces students' interest and motivation in understanding mathematical concepts. To address this challenge, this study developed an Android-based ethnomathematics puzzle game as an interactive learning medium that not only delivers material but also incorporates local cultural values. One of the integrated topics in this game is plane geometry. This study aims to develop a learning medium that meets the criteria of validity, practicality, and effectiveness. The study was conducted using the Research and Development (R&D) approach based on the 4-D model. Research activities were implemented at public junior high schools in the Pesawaran Regency area Lampung, involving 183 students as research subjects. Data were collected through observations, interviews, and tests, then analyzed descriptively. The validation results showed that the developed product received an average validation score of 81.0 from media experts and 81.0 from material experts, categorized as valid. In terms of practicality, this medium achieved an average score of 44.5, classified as excellent. Meanwhile, the effectiveness of the product was tested by comparing pretest and posttest scores in two class experiment and control, The analysis of N-Gain Scores indicated that the experimental class averaged 58.92, whereas the control class averaged 9.40. These findings indicate that the Android-based ethnomathematics puzzle game is effective in improving students' understanding of plane geometry concepts.

Keywords: Ethnomathematics Puzzle Game; Plane Geometry, Validity, Practicality, Effectiveness.

Abstrak

Rendahnya hasil belajar matematika dalam lingkungan siswa menjadi permasalahan yang memiliki pengaruh pendting di dalam pendidikan, terutama akibat kurangnya media pembelajaran yang inovatif dan kontekstual. Selain itu, keterbatasan dalam pemanfaatan teknologi sebagai alat bantu pembelajaran menyebabkan ketertarikan dan motivasi siswa yang minim dalam memahami konsep-konsep matematika. Untuk mengatasi tantangan ini, penelitian ini mengembangkan game puzzle etnomatematika berbasis Android sebagai media pembelajaran interaktif yang tidak hanya menyampaikan materi tetapi juga mengangkat nilai-nilai budaya lokal. Salah satu materi yang diintegrasikan dalam game ini adalah geometri bangun datar. Penelitian ini dilakukan dengan maksud menciptakan media pembelajaran yang praktis, valid dan terbukti efektif. Pendekatan yang digunakan berupa penelitian dan pengembangan (R&D) dengan memanfaatkan model pengembangan 4-D. Penelitian ini dilaksanakan di kabupaten pesawaran lampung pada jenjang SMP dengan melibatkan 183 peserta didik sebagai subjek penelitian. Data dikumpulkan melalui observasi, wawancara terhadap siswa, dan tes, lalu data dianalisis secara deskriptif. Hasil validasi menunjukkan bahwa produk yang dikembangkan memperoleh skor rata-rata validasi ahli media sebesar 81,0 dan ahli materi 81,0, yang masuk dalam kategori valid. Dari segi kepraktisan, media ini meraih skor rata-rata 44,5 yang termasuk dalam kategori sangat baik. Adapun efektivitasnya dianalisis melalui perbandingan hasil tes awal dan tes akhir pada kedua kelas. Berdasarkan Hasil analisis N-Gain menunjukkan rata-rata skor kelas eksperimen sebesar 58,92, dibandingkan 9,40 pada kelas kontrol. Temuan tersebut mengindikasikan bahwa game puzzle etnomatematika berbasis Android dapat secara efektif meningkatkan pemahaman siswa mengenai konsep geometri bangun datar.

***Kata kunci**: Game Puzzle Etnomatematika; Geometri Bangun Datar, Validitas, Kepraktisan, Efektivitas.*

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

INTRODUCTION

Mathematics represents one of the academic areas that play a crucial role in developing students' logical, analytical, and systematic thinking skills Just & Siller, (2022). However, students' mathematics learning outcomes remain relatively low, not only due to the complexity of the material but also because of factors related to students, teachers, teaching methods or media, and the learning environment (Fuentes et al., 2015). Additionally, a survey by Hidayatulloh et al., (2023), reported that 48% of students in the Asia-Pacific region consider mathematics a difficult subject to understand. Another contributing factor is the lack of teachers' skills in designing and implementing effective learning strategies (Mupa & Chinooneka, 2015).

One of the challenges in mathematics learning is the suboptimal use of instructional media. Based on an interview with a teacher at SMP N 27 Pesawaran (December 2022), the media used in mathematics learning are still limited to posters and simple tools such as square boards and rulers. This indicates a lack of innovative media that can help students better understand mathematical concepts. To address this issue, it is necessary to develop more innovative and interactive learning media that can enhance students' motivation and interest in learning. One possible solution is the integration of technology in mathematics education, particularly through digital educational games accessible via smartphones (Viberg et al., 2023), (Martínez-gómez, 2025). studies have highlighted the effectiveness of technology use in mathematics learning.

Research by Mageed (2024) and Karomah et al. (2024) found that combining puzzle media in learning can create a fun and interactive learning environment and can increase students' interest in learning mathematics by involving critical thinking and active interaction. Meanwhile, a study by Hidayatulloh et.al, (2025) and Vank, (2021) shows that puzzle games can be used as an effective learning medium to improve students' mathematics learning outcomes. Additionally, Prawismo et al. (2022) developed a digital puzzle medium for fraction learning and found that this approach significantly enhanced students' understanding.

Moreover, the ethnomathematics approach in mathematics learning has also gained attention from researchers. A study by Prahmana & D'Ambrosio, (2020) emphasized that connecting mathematical concepts with local culture can improve students' engagement and comprehension of the material. Cholily et al., (2023) and Noerhasmalina & Hidayatulloh, (2023) also stated that culturally based media have great potential in helping students better understand abstract mathematical concepts.

Although previous studies have explored the use of technology and the ethnomathematics approach in mathematics learning, some gaps remain. Most existing research has focused either on digital media or ethnomathematics separately, without integrating both into a single interactive and technology-based platform.

Furthermore, research on the development of Android-based ethnomathematical puzzle games is still very limited. Therefore, this study offers novelty by developing an Android-based ethnomathematical puzzle game that combines local cultural elements with planar geometry learning in a single digital platform. The develop-ment of this learning medium

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

employs the 4-D model to ensure that the final product attains practicality, validity, and effectiveness in the learning process.

The main issues addressed in this study include students' low mathematics achievement, particularly in planar geometry, and the lack of interactive and innovative instructional media, which contribute to students' difficulties in understanding mathematical concepts. Moreover, the integration of technology in developing culturally relevant instructional media that can enhance students' comprehension remains underutilized.

To address these issues, this research focuses on developing an Android-based ethnomathematical puzzle game as an interactive learning medium that integrates mathematical concepts with local culture. This game is Intended to stimulate students' curiosity and interest and motivation in learning mathematics in an engaging way. Using the 4-D development model, the media will be validated by experts and tested for its effectiveness in learning. Additionally, this game-based instructional media is designed in alignment with Bruner's learning theory, which emphasizes the importance of visual and manipulative tools in understanding mathematical concepts Cholily et al., (2023) Through this approach, students can learn more effectively by actively interacting with the material presented structured as puzzle games.

This study seeks to create an Android-based ethnomathematics puzzle game as a learning tool for mathematics, evaluate its validity through expert judgment, examine its practicality using feedback from teachers and students, and analyze its effectiveness in enhancing students' achievement in plane geometry. The results of this study are anticipated to contribute to further advancement of learning media that integrate technology and culture, and at the same time promoting the overall quality of mathematics teaching in schools.

METHODS

The study employs the 4-D (Four-D Models) development framework, which includes four key phases define, design, develop, and disseminate as presented in Figure 1.

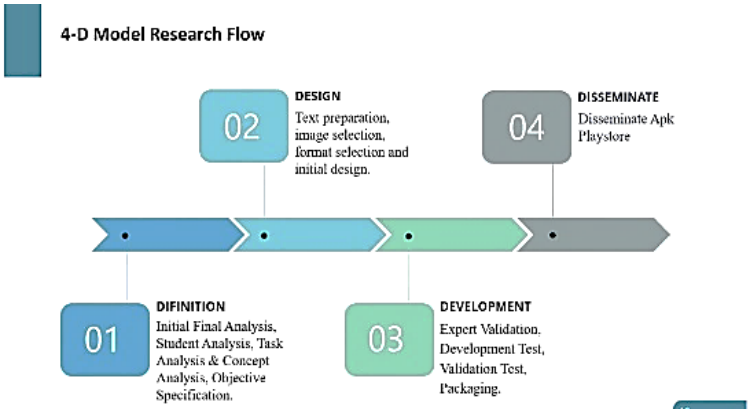

Figure 1. Syntax Development Model.

The participants of this study consisted of 183 seventh grade students from public junior high schools in Pesawaran Regency, Lampung. To gather the necessary data, the study employed several instruments, such as

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

validation forms, practicality questionnaires, and tests of learning outcomes. The validation procedure involved two categories of experts: specialists in the subject matter and experts in instructional media. The subject matter validation consisted of 16 questions assessing the clarity of learning objectives, media presentation, content, language, and practicality. Meanwhile, the media expert validation comprised 9 questions focusing on content and language aspects. Additionally, a product practicality questionnaire was distributed to students, consisting of 10 questions covering aspects such as enjoyment, novelty, and students' learning interest.

Student learning outcomes are measured using multiple-choice tests as indicators of the success relate of learning process. With regard to this research, learning outcomes are defined as the behavioral changes exhibited by students after completing learning activities

The quality of the developed product, in the form of an ethnomathematics puzzle game media, is evaluated based on three main aspects: product design, practicality, and effectiveness. The media is considered valid if there is alignment between the characteristics of the learning media used and the developed ethnomathematics puzzle game. A product is deemed feasible if it meets the established feasibility standards. The practicality of the product is examined by evaluating its validity through expert assessments and by analyzing students' responses to Learning media designed for this purpose the assessment instrument by Hidayatulloh et al., (2023), as presented in Table 1.

Table 1. Indicators of the instrument used to assess media validity.

Aspect	Indicator	Scoring Guidelines
Appearance	1. Color compatibility of images in the ethnomathematics puzzle game 2. Compatibility of the puzzle game display with the geometric material of plane figures 3. Accuracy of design layout placement according to levels 4. Compatibility of the cover and content display in the ethnomathematics puzzle game 5. Quality of image presentation in the ethnomathematics puzzle game	Maximum score 50, with each indicator valued between 0-10
Media content	1. Relevance of the material in the ethnomathematics puzzle game 2. Accuracy of puzzle piece cuts in the ethnomathematics puzzle game for plane geometry material 3. Compatibility of the ethnomathematics puzzle game with the learning model 4. The ethnomathematics puzzle game attracts students' interest in further learning 5. The answer choices in the questions effectively measure students' abilities	Maximum score 50

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

Aspect	Indicator	Scoring Guidelines
Language	. Effectiveness of sentences presented in the media . Standardization of terms . Suitability with the emotional development level of students	Maximum score 30
Practicality	. Clarity of media instructions . The ethnomathematics puzzle game is easy to download on the Play Store . Consistency in the use of navigation buttons	Maximum score 30
Average Validity Score (V)= $\frac{Score\ Total}{160}$		**categories (Validitas)**

In the rubric table of this assessment instrument, there are three evaluators with four rating scale categories. According to Aiken (1985:134) in Yahfizham et al., (2021), the Aiken index must have a *V* value or validity level ranging from 0 to 1, with categories as shown in Table 2.

Table 2. Aiken's Validity Coefficient

Nilai Koefisien Validitas Aiken (v)	Validitas
$0 < V \leq 0{,}4$	Low
$0{,}4 < V \leq 0{,}8$	Medium
$0{,}8 < V \leq 1$	High

The learning media is considered valid if it meets the validation criteria, which depend on the number of evaluators and the assessment categories used, along with the obtained validity category. The effectiveness test of the ethnomathematics puzzle game media is conducted by analyzing students' post-test scores after completing the questions in the ethnomathematics puzzle game. The effectiveness indicator of the product is determined based on the criterion that 85% of students who take the test achieve the required score. Furthermore, the N-Gain calculation was conducted using a One Group Pretest and Posttest to To examine the enhancement of students' learning outcomes following the use of learning media.

RESULTS AND DISCUSSION

Definition stage (Define) is carried out to obtain an overview of the Several factors influence the challenges faced in mathematics learning, including student conditions, the teaching methods implemented by educators, and the instructional media used during the learning process. A needs analysis, conducted through interviews with middle school teachers in Pesawaran Regency, revealed that the current learning approach remains predominantly teacher-centered. Lessons are primarily delivered through traditional lecture methods and question-and-answer sessions, limiting students' engagement and active participation in the learning process.

One of the key issues identified is the insufficient availability of supporting facilities and infrastructure, which significantly impacts students' attention and enthusiasm for learning. The absence of engaging and interactive learning materials also leads resulting in a decrease in students' interest in mathematics, making it harder for them to understand abstract concepts. Without adequate resources and innovative teaching strategies, students tend to become passive learners, which hinders their overall academic progress and comprehension of mathematical concepts.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

Interviews with several students revealed that they actively use Android phones for various academic purposes, such as downloading learning materials and communicating via WhatsApp groups with family, friends, and teachers. This finding indicates that Android devices have become an essential part of students' daily lives, particularly in supporting their learning process. Based on this information, the researchers concluded that implementing an Android-based ethnomathematics puzzle game is a suitable approach, as it aligns with students' existing habits of utilizing technology for educational purposes. This conclusion is further supported by research conducted by Rahmi, (2024), which suggests that the integration of Android-based tools in learning can improve student participation and motivation.

The design stage (Design) involves researchers designing the Android-based ethnomathematics puzzle game. This stage includes several steps, namely preparing the test, selecting the media, determining the format, and creating the initial prototype. At this stage, the researchers create validation questionnaires, test questions, and the design of the ethnomathematics puzzle game. The test for learning outcomes is designed to assess students' abilities and comprehension after engaging in the learning process. Selection of Android-based media is driven by the fact that most students already own Android devices and show a preference for game-based learning, making it a familiar and engaging platform for educational activities.

The ethnomathematics puzzle game offers a flexible learning experience, allowing students to access educational content anytime and anywhere. This approach aligns As part of the research conducted by Sari et al., (2024) which indicates that interactive digital media can greatly improve students' understanding of abstract concepts compared to traditional learning methods

To ensure that the game is both educational and visually engaging, the selected format incorporates illustrations closely related to lesson materials. These components feature visuals such as maps of Java Island, illustrations of human organs, pictures of Borobudur Temple, national heroes, and other culturally meaningful images. In this study, Lampung batik patterns and cultural attributes are also incorporated into the game, providing unique characteristics that enhance the learning experience and promote a stronger appreciation of local heritage.

The development stage (Develop) is carried out to evaluate the feasibility and practicality of the ethnomathematics puzzle game as an educational tool. This evaluation process involves expert validation and product trials to ensure that the media meets both educational and usability standards before being implemented in a real learning environment.

The validation by media experts focuses on several key aspects, including the overall design appearance, the appropriateness and accuracy of the media content, the clarity and effectiveness of the language used, and the practicality of the game in facilitating learning. These aspects are carefully assessed to ensure that the game is not only visually appealing and engaging but also pedagogically sound and user-friendly for students. Furthermore, product trials are conducted with a sample of students to gather direct feedback on the game's usability,

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

engagement level, and effectiveness in enhancing learning outcomes. The results of these evaluations are then used to refine and improve the game, ensuring that it aligns with both educational objectives and students' learning preferences. The media validation result can be seen in Table 3.

Table 3. Validation results by media experts based on four aspects of assessment indicators

No	Indicator	Percentage
1	Appearance	75 %
2	Media content	92 %
3	Language	92 %
4	Practicality	75 %

Based on the data presented in Table 3, it can be observed that the percentage of assessment results varies across different evaluation aspects. Specifically, the appearance aspect received a score of 75%, the media content aspect achieved 92%, the language aspect also scored 92%, and the practicality aspect obtained 75%. These results reflect the overall quality and effectiveness of the ethnomathe-matics puzzle game in terms of visual design, content accuracy, linguistic clarity, and usability.

The average assessment score given by media experts reaches 81%, which falls into the category of "very valid" or "high validity." This classification indicates that the developed media meets the necessary standards for educational use and is highly Appropriate for implementation in the process of learning. The high scores in media content and language aspects suggest that the material is well-structured and effectively communicated, while the slightly lower scores in appearance and practicality highlight areas that may require further refinement to enhance user experience and ease of use.

Overall, these evaluation results confirm that the ethnomathematics puzzle game is a well-designed and reliable educational tool that can effectively support students' learning processes. Further improvements may focus on optimizing the visual presentation and practicality aspects to ensure maximum engagement and usability. Meanwhile, validation by subject matter experts evaluates the material and language aspects. The assessment results can be seen in Table 4.

Table 4. Validy results by subject matter experts based on two sub-aspects of material assessment indicators.

No	Indicator	Percentage
1	Material	75 %
2	Language	92 %

The validation outcomes strongly indicate that the ethnomathematics puzzle game is appropriate for use as a learning medium. For content quality, the expert provided a score of 88%, categorized as "very good." This shows that the game's material is relevant, accurate, and well-aligned with the learning objectives, making it highly suitable for educational implementation.

From the language aspect, the validator provided a score of 75%, also categorized as "very good." This suggests that the language used in the game is clear, comprehensible, and appropriate for the target audience. However, there may still be room for minor refinements to enhance clarity and accessibility, ensuring that students of different backgrounds and learning levels can fully benefit from the game.

The findings from this validation align with research conducted by Rahmawati & Jamaluddin, (2024), which highlights that game-based interactive learning media can

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

significantly enhance the effectiveness of delevering material in mathematich learning. By incorporating engaging and interactive elements, such media can facilitate a deeper understanding of concepts while simultaneously fostering active student participation in the learning process. Given these validation results and supporting research, the ethnomathematics puzzle game demonstrates strong potential for effective implementation in learning environments. Further improvements, particularly in language refinement and user experience optimization, could enhance its overall impact and usability, ensuring that it remains an engaging and effective tool for students. The visual display of the ethnomathematics puzzle game is shown in Figure 2.

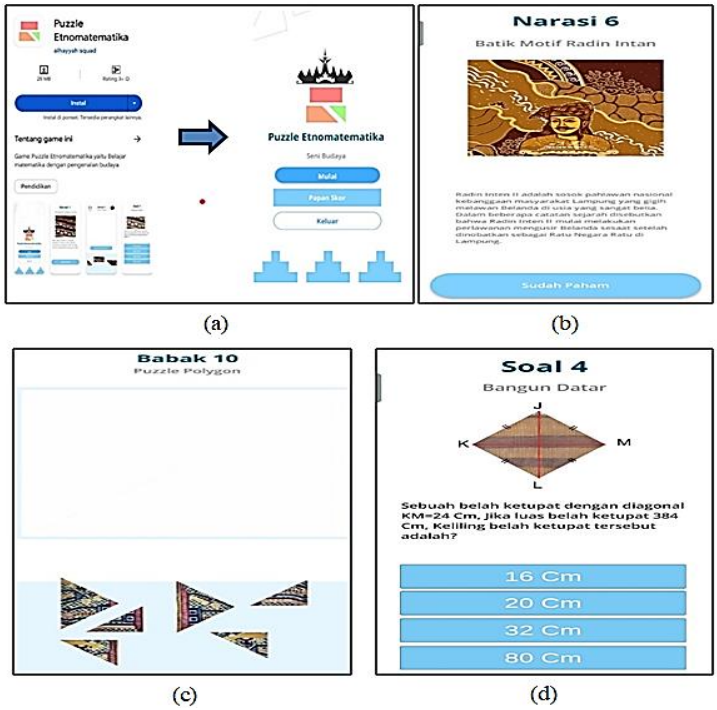

Figure 2. (a) Initial screen; (b) manarration; (c) game; (d) questions in the Ethnomathematics puzzle game.

The Disseminate stage was conducted to evaluate the effectiveness of the Android-based ethnomathematics puzzle game through large-scale implementation. This stage involved 183 students from three different schools in Pesawaran Regency, namely SMPN 1 Pesawaran, SMPN 17 Pesawaran, and SMPN 27 Pesawaran. To provide a thorough evaluation, the students were separated into two groups: a control class and an experimental class.

During the pretest phase, it was observed that students' initial understanding of plane geometry was still relatively low. This finding indicated that before the introduction of the developed learning media, students had limited prior knowledge of the subject and struggled to grasp its concepts effectively. The results emphasized the need for innovative and engaging learning strategies to improve student comprehension and participation in mathematics. Following the implementation of the Android-based

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

ethnomathematics puzzle game in the experimental class, there was a noticeable improvement in students learning outcomes. The data revealed that 79 students achieved a high N-Gain Score category with a score above 70, while 14 students were categorized as having a medium N-Gain Score, with values ranging between 30 and 70. Notably, none of the students in this class fell into the low category, demonstrating the game's effectiveness in enhancing understanding and retention of mathematical concepts. The overall increase in pretest-posttest scores in the experimental class reached 58.92, which falls within the medium interpretation category, signifying substantial progress related to students' learning results.

On the other hand, in the control class, where traditional teaching methods such as lectures and question-and-answer sessions were used, the improvement in learning outcomes was significantly lower. The results showed that 32 students managed to attain a high N-Gain Score, while 60 students were classified within the medium N-Gain Score range. Similar to the experimental class, there were no students in the low category. However, the overall increase in pretest-posttest scores in this class was only 9.40, which, although still falling within the medium interpretation category, was far lower than that of the experimental class.

When comparing the two groups, a significant difference in learning outcomes was observed. The N-Gain score on average in the control class was recorded at 9.40, whereas the experimental class achieved 58.92. This substantial gap strongly indicates that the integration of the Android-based ethnomathematics puzzle game in the learning process provided a much more effective and engaging approach to teaching plane geometry.

Findings of this study confirm that the developed educational game serves as an innovative and interactive learning tool that enhances students' comprehension of mathematical concepts. By incorporating ethnomathematics elements into digital game-based learning, students are not only able to understand abstract mathematical theories more effectively, but they also develop a stronger interest in the subject. Given these promising findings, the Android-based ethnomathematics puzzle game proves to be a highly effective learning medium for improving mathematics education, particularly among junior high school students in Pesawaran Regency, Lampung.

This Study found that consistent with earlier research and further support the idea that digital learning media significantly contribute to improving students' academic achievement. Studies undertaken by Muhaimin & Juandi (2023) shows that employing digital learning media can greatly enhance students' conceptual understanding, enabling them to comprehend complex mathematical concepts more effectively than with conventional instructional approaches. Additionally, a study by Mahmud, (2023) found that interactive game-based learning positively impacts students' motivation to learn, making learning activitie more engaging and stimulating. Furthermore, research by Prawismo et al., (2022) highlights that incorporating technology into the learning process enhances the link between theoretical ideas and students' real-world experiences, which is consistent with the findings of this study. This suggests that students can relate abstract mathematical principles

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

to real-world contexts more effectively when learning is supported by interactive, technology-based educational tools.

The findings of this research highlight the substantial influence of Android-based ethnomathematics puzzle games in improving students' conceptual comprehension as well as their motivation to learn mathematics. The integration of interactive digital technology with cultural elements offers an engaging, contextual, and effective learning experience, assisting students in connecting mathematical ideas to their everyday experiences. Furthermore, the study emphasizes the value of incorporating local cultural elements into instructional media, showing that this strategy not only boosts student engagement but also cultivates cultural awareness and appreciation. The inclusion of elements such as Lampung batik motifs and traditional cultural symbols in the game provides students with an opportunity to learn mathematics in a way that feels more relevant and personally meaningful.

Beyond mathematics, this research suggests that the development of similar technology-based educational tools for other subject areas could serve as a promising innovation in education. Subjects such as science, history, geography, and language arts could benefit from the integration of interactive game-based learning combined with cultural and contextual elements, leading to greater student participation, enthusiasm, and comprehension. By applying this approach to other disciplines, educators can foster a more interactive and student centered intructional environment that accommodates different learning styles and needs

Thus, this study makes a valuable contribution to the advancement of technology-enhanced learning strategies. By promoting a more interactive, effective, and culturally relevant approach to education, the research reinforces the necessity of modern teaching methodologies that align with students' technological habits and learning preferences. The findings highlight the transformative potential of digital media in education, encouraging further exploration and development of engaging, technology-integrated learning resources to support students' academic success

CONCLUSION AND SUGGESTION

Based on the research findings, it can be concluded that the Android-based ethnomathematics puzzle game has proven to be an effective learning tool for improving junior high school students' understanding of plane geometry concepts. The results of the effectiveness test demonstrate that students who used this interactive learning media showed better comprehension and engagement than students who participated in traditional learning approaches. The expantion in students' educational outcomes highlights the potential of game-based digital media in making abstract mathematical concepts more accessible and enjoyable.

Moreover, the media experts' validation indicates that this learning tool meets strong feasibility criteria, confirming its appropriateness for use in educational settings. Similarly, validation from subject matter experts affirms that the ethnomathematics puzzle game effectively supports students in understanding mathematical concepts, making it a valuable instructional resource.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

With its interactive nature, cultural integration, and engaging gameplay, this Android-based ethnomathematics puzzle game offers an innovative and relevant alternative learning approach. It not only improves students' grasp of concepts but also encourages them to engage more actively in the learning process. Therefore, the present research reinforces the importance of incorporating technology-driven educational tools into mathematics instruction To foster a more engaging, efficient, and student-focused learning environment.

This study has limitations in terms of sample coverage and the scope of the tested material. Hence, it is suggested that future studies include a larger sample from various schools to obtain more generalizable results. Additionally, further studies could develop this game with more interactive features and cover a broader range of topics so that it can be applied to other mathematical concepts. Long-term effectiveness testing is also necessary to evaluate how this media influences students' conceptual understanding and learning motivation across a longer timeframe.

REFERENCES

Cholily, Y. M., Darmayanti, R., Lovat, T., Choirudin, C., Usmiyatun, U., & Muhammad, I. (2023). Si-GEMAS: Serious game mathematical crossword puzzle learning media for students critical thinking ability. *Al-Jabar : Jurnal Pendidikan Matematika*, *14*(1), 165–179. https://doi.org/10.24042/ajpm.v14i1.16113

Fuentes, F., Keith, B., Demkowicz, L., & Nagaraj, S. (2015). Orientation embedded high order shape functions for the exact sequence elements of all shapes. *Computers and Mathematics with Applications*, *70*(4), 353–458. https://doi.org/10.1016/j.camwa.2015.04.027

Hidayatulloh et.al. (2025). The Effectiveness of Puzzle Game-Based Learning Media in Improving Mathematics Science Problem Solving Skills. *Jurnal Pendidikan dan Penelitian Mipa 11*(3), 946–953. https://doi.org/10.29303/jppipa.v11i3.10625

Hidayatulloh, Kristiawan, M., B, N. A. Y., Apryani, D., & Noerhasmalina. (2023). Optimizing Vibrant School Lampung Interactive Learning Media on Development Materials , Roots, and Logarithms. *Al-Ishlah Jurnal Pendidikan 15*, 2534–2542. https://doi.org/10.35445/alishlah.v15i2.2389

Just, J., & Siller, H. (2022). Education sciences The Role of Mathematics in STEM Secondary Classrooms : A Systematic Literature Review. *Educ. Sci.* 2022, *12*(9), 629; https://doi.org/10.3390/educsci12090629

Karomah, S., Deny Setiawan, & Siti Zubaidah. (2024). Developing Puzzle Based Case Study to Improve Cognitive Learning Outcomes of High School Students. *Prisma Sains*, *12*(3). 411-427 https://doi.org/10.33394/j-ps.v12i3.11642

Mageed, I. A. (2024). The Mathematization of Puzzles or Puzzling Mathematics Innovative Teaching of Mathematics. September. *europepmc, 1 (09)* 1-

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

22 https://doi.org/10.20944/preprints202409.0609.v1

Mahmud M. S. (2023). Influence of game-based learning in mathematics education on the students. *Frontiers in Psychology*, *14*(2023). 01-15 https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2023.1105806

Martínez-gómez, J. (2025). Enhancing Mathematical Education Through Mobile Learning : A Problem-Based Approach. *mdpi-Education Sciences* 1–15. 15(4):462. DOI:10.3390/educsci15040462

Muhaimin, L. H., & Juandi, D. (2023). The Role Of Learning Media In Learning Mathematics : A Systematic Literature Review. *Journal of Mathematics and Mathematics Education*, *13*(01), 85-107. https://doi.org/10.20961/jmme.v13i1.74425

Mupa, P., & Chinooneka, T. I. (2015). Factors Contributing to Ineffective Teaching and Learning in Primary Schools: Why are Schools in Decadence? *Journal of Education and Practice*, *6*(19), 125–133. https://doi.org/10.7176/JEP.

Noerhasmalina, N., & Hidayatulloh, H. (2023). Mapping the landscape: Growth and trends in ethnomathematics research – A bibliometric review. *Al-Jabar : Jurnal Pendidikan Matematika*, *14*(1), 216–225. https://doi.org/10.24042/ajpm.v14i1.18264

Prahmana, R. C. I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the batik patterns of yogyakarta, indonesia. *Journal on Mathematics Education*, *11*(3), 439–456. https://doi.org/10.22342/jme.11.3.12949.439-456

Prawismo, S. A., Sajida, A. H., Habibah, P. J. M., Zainuddin, M., & Mas'ula, S. (2022). Pengembangan Media Puzzle dalam Pembelajaran Materi Pecahan bagi Siswa Kelas Rendah SD Negeri Jatinom 03. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, *5*(2), 102. https://doi.org/10.33603/caruban.v5i2.6846

Rahmawati, S., & Jamaluddin, M. (2024). Development of Game-Based Mathematics Learning Media to Improve Mathematical Understanding Abilities. Riemann : *research of mathematich and mathematich education 6*(2), 202–214. https://doi.org/10.38114/pnn19445

Rahmi, H. (2024). Development of the Android-Based Edutainment Game 'Tekamatika' to Enhance Students' Creative Thinking Skills. *JDIME : Journal of Development and Innovation In Mathematics Education, 2*(1), 49–59. https://doi.org/10.32939/jdime.v2i1.4148

Sari, M., Hariyanti, F., Muhammad, S., & Farooq, Y. (2024). The Effect of Interactive Media on Students ' Mathematical Communication Ability Based on Learning Styles. *Delta-Phi: Jurnal Pendidikan Matematika 2(April), 43–52.* https://doi.org/10.61650/dpjpm.v2i1.752

Vank, P. (2021). Influence of Game-

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v15i1.9531

Based Learning in Mathematics Education on Students ' Affective Domain : A Systematic Review. Mathematics. *mpdi-Journals Mathematics 9*(9), 986; https://doi.org/10.3390/math9090986

Viberg, O., Grönlund, Å., Andersson, A., & Viberg, O. (2023). Integrating digital technology in mathematics education : a Swedish case study Swedish case study. jounal *Interactive Learning Environments*, 31, 2023 (1). *4820*. https://doi.org/10.1080/10494820.2020.1770801

Yahfizham, Yusti, I., & Hamzah, M. L. (2021). The Test of Construct Validity for One-Factor Model. *Journal of Educational Research and Evaluation*, *5*(3), 429–435. https://doi.org/10.23887/jere.v5i3.33285