

DEVELOPMENT OF ANDROID-BASED EDUCATIONAL GAME LEARNING MEDIA USING CONSTRUCT 2: AMAE JOURNEY ON ALGEBRA MATERIAL

Imam Sa'id Nurfrendi¹, Uki Suhendar^{2*}, Wahyudi³

^{1,2*,3} Universitas Muhammadiyah Ponorogo, Ponorogo, Indonesia
^{*}Corresponding author. Jl. Budi Utomo No.10, 63471, Ponorogo, Indonesia

E-mail: frendix45@gmail.com¹
ukisuhendar@umpo.ac.id^{2*}
wahyudi@umpo.ac.id³

Received 20 May 2025; Received in revised form 27 July 2025; Accepted 02 September 2025

ABSTRACT

This research aims to develop educational game-based learning media using Construct 2, which is named AMAE JOURNEY. This game is designed to increase students' interest in learning and mathematical ability. The method used is Research and Development (R&D) with the ADDIE model, which includes Analyze, Design, Develop, Implement, and Evaluate. Analyze, involving performance analysis and literature review to identify learning needs and context. Design, where the initial product is planned by selecting components, preparing materials, and determining appropriate sound effects and music. Develop, which includes product creation, material and media expert validation, and subsequent product revision. Implement, involving group trials to test the product in an actual learning setting. Evaluate, conducted through practicality and effectiveness tests using qualitative and quantitative data. Subjects involved include material experts, media experts, and students. Data are collected through validation sheets, questionnaires, and tests to measure the validity, practicality, and effectiveness of the product. The results showed that this game is very valid, practical, and effective as a learning media. Material and media expert validation scored 90%, while the practicality test by students reached 83,20%. The effectiveness test also scored 83,35%. The pilot test at SMPN 2 Badegan proved that the game is interesting, easy to use, and able to increase students' interest and understanding of algebra. Using a one-shot case study approach, the results showed a positive impact on students' motivation and ability. This media can be an effective alternative for teachers in delivering material in a more interest learning.

Keywords: ADDIE, algebra, android, educational game, research and development

ABSTRAK

Penelitian ini bertujuan untuk mengembangkan media pembelajaran berbasis game edukasi dengan menggunakan Construct 2, yang diberi nama AMAE JOURNEY. Game ini dirancang untuk meningkatkan minat belajar dan kemampuan matematika siswa. Metode yang digunakan adalah Research and Development (R&D) dengan model ADDIE, yang meliputi Analyze, Design, Develop, Implement, dan Evaluate. Analyze, melibatkan analisis kinerja dan tinjauan literatur untuk mengidentifikasi kebutuhan dan konteks pembelajaran. Design, dimana produk awal direncanakan dengan memilih komponen, menyiapkan materi, dan menentukan efek suara dan musik yang sesuai. Develop, yang meliputi pembuatan produk, validasi ahli materi dan media, dan revisi produk selanjutnya. Implement, melibatkan uji coba kelompok untuk menguji produk dalam situasi pembelajaran yang sebenarnya. Evaluasi, dilakukan melalui uji kepraktisan dan keefektifan dengan menggunakan data kualitatif dan kuantitatif. Subjek yang dilibatkan meliputi ahli materi, ahli media, dan siswa. Data dikumpulkan melalui lembar validasi, kuesioner, dan tes untuk mengukur kevalidan, kepraktisan, dan keefektifan produk. Hasil penelitian menunjukkan bahwa game ini sangat valid, praktis, dan efektif sebagai media pembelajaran. Validasi ahli materi dan media mendapatkan nilai 90%, sedangkan uji kepraktisan oleh siswa mencapai 83,20%. Uji keefektifan

juga mencapai 83,35%. Uji coba di SMPN 2 Badegan membuktikan bahwa game ini menarik, mudah digunakan, dan mampu meningkatkan minat dan pemahaman siswa terhadap aljabar. Dengan menggunakan pendekatan one-shot case study, hasil penelitian menunjukkan adanya dampak positif terhadap motivasi dan kemampuan siswa. Media ini dapat menjadi alternatif yang efektif bagi guru dalam menyampaikan materi dengan cara yang lebih menarik.

Kata kunci: ADDIE, aljabar, android, game edukasi, penelitian dan pengembangan

This is an open access article under the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)



Introduction

Mathematics learning in schools, especially at the primary and secondary education levels, still faces various complex and ongoing challenges. One of the main problems often faced by teachers and students is the low interest and motivation of students in participating in mathematics learning (Tambunan et al., 2021). Math is often perceived as a subject that is difficult, boring, and far from real life. This negative perception causes many students to experience mathematics anxiety, which in turn has an impact on low active participation in the learning process and a weak understanding of basic concepts that should be the foundation for higher-level learning (Ramirez et al., 2018). This condition not only affects the achievement of student learning outcomes, but also hinders the development of logical, critical and analytical thinking skills that are needed to face the challenges of the 21st century.

This problem is further exacerbated by learning approaches that are still dominated by conventional methods, such as monotonous teaching and practice questions, without any media innovation that can accommodate students' diverse learning styles. In the current educational context, where students are a digital generation who are very familiar with technology, the use of static and less interactive learning media is an obstacle in creating a meaningful and enjoyable learning experience (Hernandez-de-Menendez et al., 2020). In fact, technology has great potential to be integrated into the learning process to create a more dynamic atmosphere and in accordance with the characteristics of today's students (Akram et al., 2022).

Integrating technology in the learning process is one of the main strategies to overcome various obstacles found in conventional teaching methods (Haleem et al., 2022). Some mathematics learning still uses conventional methods, even though mathematics learning is often one of the subjects that students find difficult due to its abstract and complex nature (Sugiarti & Retnawati, 2019). According to Sitopu et al. (2024), mathematics education is not just a subject in school, but also an educational strategy that adapts to the evolving needs of students in the 21st century. Therefore, mathematics teaching methods must be considered according to the needs of the times and adapted to the needs of students.

On the other hand, the phenomenon of increasing use of technological devices such as smartphones by students shows great potential to be utilized in the context of learning (Anshari et al., 2017). Data from various national and global surveys show that the majority of learners currently have access to smartphones and actively use them in their daily lives, especially for entertainment and

communication. Unfortunately, the utilization of these devices in formal learning is still relatively low (Anwas, 2019). This is ironic, considering that these devices can be an effective means to deliver digital, flexible and interactive learning if designed with the right pedagogical approach.

Seeing these conditions, concrete efforts are needed to develop innovative learning media that are not only technologically relevant, but also able to answer the pedagogical and psychological needs of students in learning mathematics. One strategic solution that can be developed is a math-based educational game application. Educational games, as a combination of entertainment and educational elements, have the potential to create a more interesting and challenging learning atmosphere. Through visually appealing features, structured game challenges, and instant feedback, students can learn math actively, independently, and enjoyably. The use of educational games on smartphone devices also allows flexibility in learning time and place, so that students can access the material anytime and anywhere.

One solution that can be applied in improving students' interest in mathematics is the implementation of technology-based learning media, such as educational games (Anggraini, 2023). Liu et al. (2020) explained that the use of educational games in learning can foster a more engaging and dynamic learning atmosphere. This is reinforced Kayan & Aydin, (2023), educational games allow students to learn through direct experience, so that students can understand math concepts more deeply without feeling burdened by conventional learning methods that tend to be monotonous.

One software that can be used to develop technology-based learning media with an educational game system is Construct 2 (Alom et al., 2016). Permatasari et al. (2022) emphasized that by using Construct 2 software, anyone can design games quickly and easily without the need to master complex programming languages. The software provides various features that support the development process, such as various types of objects, visual effects, and mechanisms. Construct 2 allows users to express their creativity in the form of games without facing significant technical constraints. By utilizing technology, educational games can also adjust the level of difficulty of the material to the ability of each student, thus increasing the effectiveness of learning and reducing anxiety about mathematics (Lopez et al., 2023).

Based on initial observations and interviews with mathematics teachers and students at SMPN 2 Badegan, it shows that the teaching method is still conventional without using technology. In addition, it was found that students' interest in learning and mathematical ability, especially in algebra material, has decreased. To overcome these problems, innovation in learning methods is needed, one of which is by utilizing technology. In line with research Kartika et al. (2019), Android-based educational games can be a solution to increase students' interest in learning and mathematical ability such as in math adventure. This educational game is designed to make learning more interesting and interactive, so that students can learn while playing. This research is important to provide alternative solutions for schools to use technology-based educational game media in teaching and learning activities. In addition, supported by research conducted by Sahid et al. (2024), it is stated that educational game media is highly sought after by students.

In recent years, the implementation of technology-based learning media has become a major focus in educational innovation, especially in addressing the challenge of students' low understanding and motivation to learn mathematics. However, although the theoretical and technological foundations are well available, there is a significant research gap. Existing studies tend to only explain the theoretical advantages of educational games in general, without specifically touching on the development and evaluation aspects of algebra learning media designed with a systematic and technology-based approach. There are not many real implementation models that integrate pedagogical elements, interactive visuals, and the context of algebra material harmoniously. Moreover, the lack of research using Construct 2 specifically in the development of algebra-themed educational media at the junior high school level shows a real and urgent research gap to be answered.

Thus, innovative learning media is needed that can address the challenges in algebra learning and aligns with the characteristics of today's students. This study aims to develop AMAE JOURNEY: Algebra Math Adventure Education Journey, an Android-based educational game with an adventure theme built with Construct 2. In addition to focusing on technical aspects, this research also assesses the validity, practicality, and effectiveness of the media in enhancing students' interest in learning and mathematical ability. Through this approach, the development of educational math games is expected not only to be an alternative but also a necessity in creating engaging, adaptive, and pedagogically meaningful learning.

Research methods

This research uses the Research and Development (R&D) method, producing an educational game application called AMAE JOURNEY. This development process follows the ADDIE model from Robert Maribe Branch in 2009. The ADDIE learning development model was first introduced by Robert Maribe Branch, an expert in the field of instructional design and technology in his book *Instructional Design: The ADDIE Approach*. Branch emphasizes that each stage in this model is flexible and can be adapted as needed, rather than a rigid linear process. Branch, explains that ADDIE is an acronym for the five systematic stages: Analyze, Design, Develop, Implement, and Evaluate. This model was developed as a framework for creating effective and efficient learning systems. This method was chosen because it provides a systematic structure for developing educational products that can be tested and refined in stages. The main model in this research uses the ADDIE model (Branch, 2009), but the steps are systematically use reference from (Cahyadi, 2019), can be seen in Figure 1.

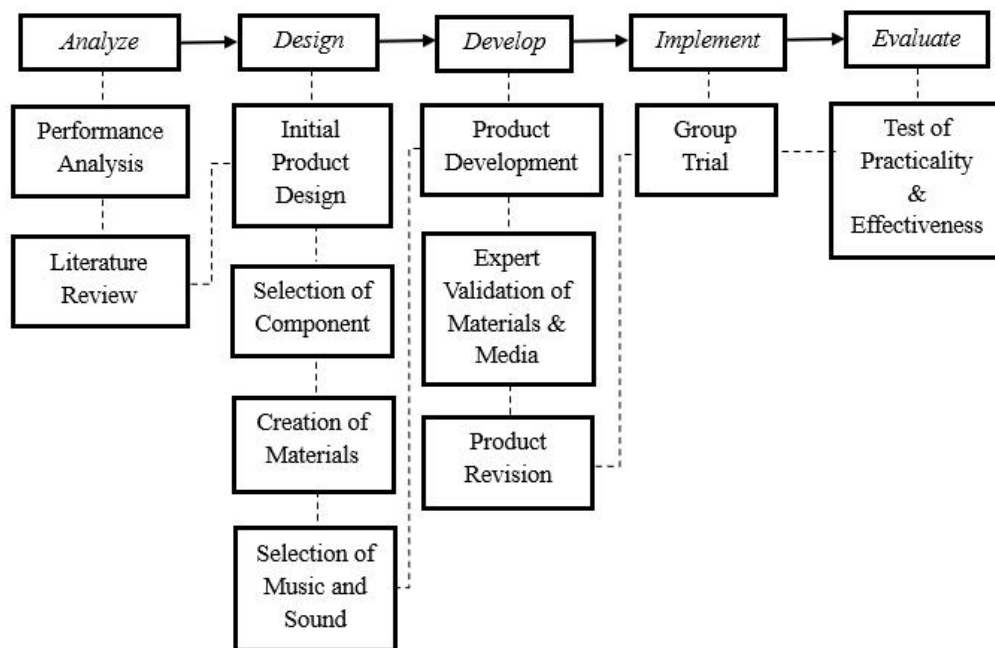


Figure 1. ADDIE stages

This study involved all seventh grade students at SMPN 2 Badegan as the population, with a sample of 25 students of class VII A. The purposive sampling technique was used because the research focused on technology-based media, so students with a good understanding of technology were selected based on previous observations.

In this study, the data collection instruments consist of questionnaires and multiple-choice tests. The data in this study are quantitative and qualitative data obtained from questionnaires and tests. The questionnaire is used to measure the validity level from subject material experts and media experts, test practicality based on student responses, and evaluate the effectiveness of media in increasing student learning interest. The questionnaire instrument is designed using 4 point Likert scale. Before use, the questionnaire underwent a validation process by experts with results indicating that the instrument is suitable for use.

Multiple choice tests are used to measure the effectiveness of media on students' mathematical abilities, particularly in the subject of algebra. This test consists of 10 multiple choice questions developed based on indicators of mathematical thinking skills, covering aspects of concept understanding and application. The questions have undergone a content validation process by mathematics education experts to ensure alignment with learning objectives and the cognitive levels measured, as well as to ensure that the difficulty level falls within an acceptable category.

This measurement is included in the category of pre-experiment research with the one-shot case study method. In this design, no pre-test was conducted, so the results of the study were only based on post-test measurements. The choice of this method is based on time constraints and research conditions that do not allow for initial measurements. This method can provide an initial picture of the impact of using game-based learning media on students.

The validation questionnaire (10 items), practicality (10 items) and effectiveness of learning interest (16 items) using a Likert scale is shown in Table 1.

Table 1. Likert Scale Questionnaire

Score	Description
4	Very good
3	Good
2	Fair
1	Poor

While the multiple choice question instrument (10 items) to test the effectiveness of mathematical ability using a binary scale is shown in Table 2.

Table 2. Binary Scale

Score	Description
1	True
0	False

Data analysis techniques from the validity, practicality, and effectiveness tests were carried out by calculating the percentage of each test. The formula for the percentage analysis technique is as follows:

$$\text{percentage (N)} = \frac{\sum \text{score per item}}{\sum \text{maximum score}} \times 100 \%$$

To present a data classification that allows a clearer interpretation of the information obtained, the results of the percentage calculation are then categorized to serve as a basis for drawing conclusions based on Table 3.

Table 3. Criteria for Testing Validity, Practicality, and Effectiveness

Percentage (N)	Category		
	Validity Test	Practicality Test	Effectiveness Test
80 % < N ≤ 100 %	Very valid	Very practical	Very effective
60 % < N ≤ 80 %	Valid	practical	effective
40 % < N ≤ 60 %	Moderately valid	Moderately practical	Moderately effective
20 % < N ≤ 40 %	Less valid	Less practical	Less effective
0 % < N ≤ 20 %	Not valid	Not practical	Not effective

Source: (Hapsari & Fahmi, 2021) modified

The educational game learning media developed in this research is considered suitable for use if it meets the minimum criteria on three main points: validity, practicality, and effectiveness, with each category achieving a percentage score of more than 60%. Meeting this minimum value indicates that the media has met the basic standards as a learning tool that is content-valid, practical in its use, and effective in enhancing students' interest in learning and mathematical abilities.

Results and Discussion

This research produces the AMAE JOURNEY educational game application by applying the ADDIE stages:

Analyze

The analysis stage in this research includes product analysis and literature review to identify learning needs, understand student challenges, and formulate solutions through the creation of game-based learning media. Product analysis was conducted through interviews with students and mathematics teachers, which revealed that students' interest in learning and mathematical ability in algebra were declining. In addition, conventional teaching methods are less effective in attracting students' attention, so students have difficulty understanding algebraic concepts. The existing learning media has also not been able to overcome these problems, so an Android-based educational game was developed to increase student engagement. Furthermore, the literature review includes a review of previous research on the effectiveness of educational games in increasing students' interest and mathematical understanding, as well as the use of Construct 2 as a platform for developing educational game applications. In line with the research (Kayan & Aydin, 2023), the findings of this research confirm that educational games have great potential in increasing students' motivation and understanding of algebraic mathematics, which is the basis for designing the features and content of the AMAE JOURNEY game.

Design

The design phase focused on designing the main features and interface of AMAE JOURNEY to make it easy to use and attractive. The game flow was structured in stages, starting from basic concepts to advanced levels, to enhance learning effectiveness. In the initial product design, the basic framework of the game was developed, including interface sketches, intuitive navigation, and presentation of interactive quizzes with immediate feedback to reinforce student understanding. The development of learning content includes the selection of technical elements such as animations, icons and interactions that are customised to integrate well with the Construct 2 platform and run optimally on Android devices. Algebra material in the game is delivered through multilevel quizzes with respect to basic competencies. In addition, the selection of soft background music and sound effects that support the transition between levels are used to create a comfortable and interactive learning atmosphere with an adventure concept. In line with research (Pasrellia & Disniarti, 2024), with a structured design and carefully selected components, AMAE JOURNEY can increase students' interest in learning. The design results are shown in Figure 2–8.

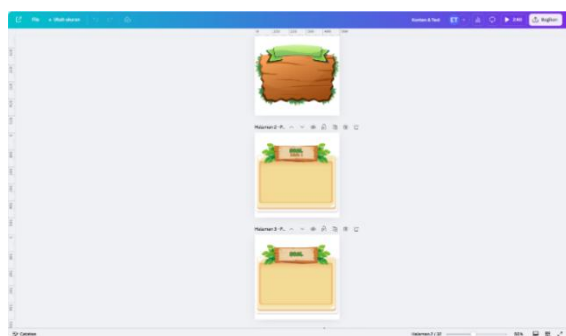


Figure 2. AMAE JOURNEY Component Creation



Figure 3. Home Page Display



Figure 4. Adventure Page View



Figure 5. Algebra Material Page Display



Figure 7. Algebra Pop-up Quiz



Figure 6. Adventure Level Page View



Figure 8. Mission Completed Display

Figure 2 to Figure 8 show the various interface components developed thematically with an interesting visual adventure approach. This aims to increase student engagement in the algebra learning process. The selection of these components is designed according to the principles of gamification, which is the use of game elements such as challenges, levels, scores, and attractive visuals in an educational context. The results of this design support the hypothesis that the application of gamification can increase student motivation and engagement in learning mathematics.

Develop

The development of this game was done using Construct 2, following a pre-designed design and includes five levels of play. Each level consists of three quizzes focusing on algebraic material. In addition to game development, this stage also involves the preparation of validation sheets for validation purposes by media experts and content experts. This validation aims to assess curriculum suitability, content accuracy, practicality of use, and attractiveness of learning media. Once the development was finalized, the game was tested by the validators to identify the strengths and weaknesses based on the feedback provided. The validity test results of AMAE JOURNEY are presented in Table 4.

Table 4. Validity Test Results

Validator	Indicators	Score	Max	%	Comment
Material expert	• Appropriateness of the curriculum	4	40	90	No revision needed
	• Clarity of concept	3			
	• Accuracy of information	4			
	• Relevance of learning objectives	4			
	• Appropriateness of education level	4			
	• Appropriateness of questions	3			
	• Student involvement	4			
	• Interesting presentation	4			
	• Skill development	3			
	• Curiosity	3			
Media expert	• Platform accuracy	4	40	90	No revision needed
	• Clarity of visual display	3			
	• Audio appropriateness	4			
	• Appropriateness of display design	3			
	• Language appropriateness	4			
	• Appropriateness of arrangement	3			
	• Clarity of instructions	4			
• Speed of access	4				
• Ease of operation	3				
• Visual appeal	4				
Average			90		

Based on Table 4 and according to the validity test results conducted by experts, both material expert validators and media experts, the results obtained that the educational game media developed were declared very valid, this refers to Table 3. Consistent with previous studies by (Umbara et al., 2021), this validation indicates that the product has met the set standards and based on the improvement suggestions does not require revision. Thus, the next stage that needs to be done is testing. This stage aims to assess the effectiveness of the learning media in the actual learning environment, to ensure that the educational games that have been developed can be used optimally by students. The development results can be seen through the QR Code shown in Figure 9.



Figure 9. AMAE JOURNEY App QR Code

Implement

After completing the development phase and gaining validation from media experts and material experts, the AMAE JOURNEY educational game was tested in class to evaluate its practicality and effectiveness. The trial involved 25 students from class VII A at SMPN 2 Badegan, who became participants in this study. The main objective of this trial was to assess the game's ability to increase students' interest in learning mathematics, as well as its impact on their mathematics skills. During the trial, students played the game on their Android devices, progressing through various levels that featured algebra-based quizzes designed to strengthen their understanding of the subject matter. Throughout this process, careful observations were made of the students' interactions with the game, including recording engagement, problem-solving strategies, and overall responses. To further evaluate the effectiveness of the game, students were given a questionnaire sheet to express their opinions on various aspects of the game. This questionnaire allowed students to provide feedback on the ease of use, the level of enjoyment while playing, and the educational benefits experienced in understanding algebraic concepts. The data collected from these observations and responses played a vital role in refining the game and ensuring its effectiveness as an engaging and interactive learning tool. The implement documentations are shown in the Figure 10-12.



Figure 10. Students Using AMAE JOURNEY



Figure 11. Students Fill out Practicality and Effectiveness Questionnaires



Figure 12. Students Working on Multiple Choice Questions

Figure 10 to Figure 12 show the AMAE JOURNEY media trial process in a classroom environment. Data from the trial shows that students were able to interact well with the app, felt motivated, and showed high interest in game-based learning. This supports research conducted by (Byun & Joung, 2018), that this media is not only practical to use, but also effective in increasing interest in learning mathematics.

Evaluate

The evaluation stage is an important part of the AMAE JOURNEY educational game development to ensure That the learning media is both practical and effective in accordance with the learning objectives. The evaluation was conducted after the pilot stage to assess the practicality and effectiveness of the game. Practicality is assessed through student feedback using a questionnaire that measures ease of use, interface navigation, and comfort while playing. Meanwhile, the effectiveness of the game was evaluated based on students' learning interest and mathematical ability on algebra material. After completing the levels in the game, students took a post-test and filled out a questionnaire to assess the extent to which the game helped students understand the material. The test results and student responses become the basis in assessing the effectiveness of AMAE JOURNEY as an interactive learning media. The practicality test results are displayed in Table 5, whereas the effectiveness test results are shown in Table 6.

Table 5. Practicality Test Results

Practicality Test	Indicators	Score	Max	%	Comment
Practical	<ul style="list-style-type: none"> • Eases • Material and animation • Language • Writing • Integrity 	832	1000	83,20	Interactive, easy to use, engaging.
Average				83,20	

Table 5 presents the results of the practicality test which are complemented by the predetermined practicality indicators. In addition, Table 5 also contains qualitative data in the form of comments or responses from students as respondents. Table 5 not only presents the numbers, but also provides an overall picture of the practicality of the media both objectively and subjectively.

Based on Table 5, the analysis of the practicality test, the evaluation results show that AMAE JOURNEY is easy to use by students, with a practicality level reaching 83.20%. Based on this percentage, then reviewed in Table 3, it is included in the very practical category. Students can quickly understand how the application works without experiencing significant difficulties, especially in learning basic algebra concepts and operating educational game applications shows in Table 6.

Table 6. Effectiveness Test Results

Effectiveness Test	Indicators	Score	Max	%	Comment
Learning interests	<ul style="list-style-type: none"> • Interest in learning • Attention to learning • Feeling of pleasure • Learning engagement 	1285	1600	80,31	None
Mathematical ability	<ul style="list-style-type: none"> • Determine similar and dissimilar terms in algebra • Determine the result of algebraic addition operation • Determining the result of algebraic subtraction operation • Solve contextual problems with algebraic addition operations • Solve contextual problems with algebraic subtraction operations 	216	250	86,40	None
Average				83,35	

Table 6 presents the data on the media effectiveness score based on the predetermined indicators, and is complemented by qualitative comments from students' responses. In addition, it provides a comprehensive picture of the effectiveness of the media in terms of learning interest and mathematical ability.

Based on Table 6, the analysis of the effectiveness test results of the learning media that has been developed, a percentage of 83.35%. The percentage is then reviewed in Table 3, including in the very effective category, indicating that the AMAE JOURNEY educational game media has a high level of effectiveness in helping students understand the material presented.

From the practicality and effectiveness tests, most students were able to use the media well and showed high interest in learning and mathematical ability after interacting with the educational game. In addition, these results also reflect that the learning media developed has met the standard of effectiveness in enhancing the teaching and learning process. With such a significant percentage, this media can be categorised as a very effective learning tool in increasing students' interest in learning and mathematical ability.

The main factors that led to this result include the attractive visual appearance, interactive game flow, and the integration of sound and animation elements that match the characteristics of junior high school students. In addition, this media is designed following the principle of student-centered learning, which allows students to be actively involved during the learning process. However, the limitation of the one-shot case study research design is a drawback because it does

not allow for comparative analysis before and after treatment and does not isolate outside variables that may affect the results.

This result aligns with the studies conducted by (Hussein et al., 2019), (Kartika et al., 2019), (Rahayu, 2023) and (Pan & Mow, 2023), which emphasize that incorporating interactive technology, such as educational games, into the learning process can enhance student engagement and make learning more enjoyable and engaging. Therefore, based on the practicality and effectiveness tests, these findings further confirm that the developed learning media is appropriate for use as an instructional tool in schools. Previous studies have shown that the development of Android-based learning media can enhance student engagement and learning outcomes. Sugiharti, Vahlia, and Rahmawati (2025) emphasized the importance of integrating local cultural values into Problem-Based Learning applications to increase the relevance of learning. Arjoni, Vahlia, Wicaksono, and Linuhung (2025) developed Android-based multimedia e-modules for junior high school students and found that these media were effective in supporting independent learning. Similarly, Winarto, Rahmawati, and Vahlia (2023) demonstrated that Android-based gamification using the Contextual Teaching and Learning approach was able to create a more engaging learning experience. These findings are also reinforced by Indriyani, ES, and Vahlia (2021) as well as Sari, ES, and Vahlia (2021), who proved the effectiveness of Android-based learning media with the Realistic Mathematics Education approach. The results indicate that the integration of digital technology in mathematics learning not only increases motivation but also facilitates conceptual understanding.

Implicatively, the results of this study make a significant contribution to the world of education, especially in the development of technology-based learning media that suits the needs of 21st century students. This media can be an effective alternative for teachers in delivering material in a more interesting and easy-to-understand manner. In addition, the use of this media has the potential to support the improvement of international assessment scores such as PISA, because it is able to foster students' mathematical abilities in learning mathematics.

Conclusions and recommendations

AMAE JOURNEY educational game has been proven to have a very high level of validity, practicality, and effectiveness as an Android-based mathematics learning media so that it can be concluded that it is very feasible to use. The use of this educational game in the learning process offers an innovative solution in increasing learning interest and mathematical ability in students' understanding of algebraic concepts. In addition, this game also has the potential to be further developed to cover other learning materials. The game-based approach allows students to be more active in understanding algebraic concepts and increase motivation in learning. This media can be an effective alternative for teachers in delivering material in a more interesting and easy-to-understand manner.

Suggestions for future research include expanding the scope of material in the game to cover more mathematics topics. In addition, the development of additional features, such as a multiplayer system, should be considered to improve interaction and collaboration between students in learning. Trials with a wider

range of participants should also be conducted to obtain more comprehensive data on the effectiveness of the game in various learning environments.

Reference

- Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. *Frontiers in Psychology*, 13(June), 1–9. <https://doi.org/10.3389/fpsyg.2022.920317>
- Alom, B. M. M., Scoular, C., & Awwal, N. (2016). Multiplayer Game Design: Performance Enhancement with Employment of Novel Technology. *International Journal of Computer Applications*, 145(1), 27–32. <https://doi.org/10.5120/ijca2016910545>
- Anggraini, W. N. (2023). Increase Interest in Learning Mathematics for 5th Grade Students Using Android Game-Based Learning Media. *International Journal of Elementary Education*, 7(4), 637–645. <https://doi.org/10.23887/ijee.v7i4.64937>
- Anshari, M., Almunawar, M. N., Shahrill, M., Wicaksono, D. K., & Huda, M. (2017). Smartphones usage in the classrooms: Learning aid or interference? *Education and Information Technologies*, 22(6), 3063–3079. <https://doi.org/10.1007/s10639-017-9572-7>
- Anwas, O. M. (2019). Kontribusi Pemanfaatan Teknologi Informasi Dan Komunikasi Di Daerah Tertinggal Contribution of Information and Communication Technology Utilization in the Underdeveloped Area. *Jurnal Teknodik*, 018–028. <https://doi.org/10.32550/teknodik.v17i3.559>
- Arjoni, R., Vahlia, I., Wicaksono, S., & Linuhung, N. (2025). Development Of Android-Based Multimedia E-Modules For Junior High School Students. *EMTEKA: Jurnal Pendidikan Matematika*, 6(1), 369-380. <https://doi.org/10.32627/emteka.v6i1.2020>
- Branch, R. M. (2009). Instructional Design: The ADDIE Approach. In *Department of Educational Psychology and Instructional Technology University of Georgia* (Vol. 53, Issue 9). <https://doi.org/10.1007/978-0-387-09506-6>
- Byun, J., & Joung, E. (2018). Digital Game-Based Learning for K–12 Mathematics Education: A Meta-Analysis. *School Science and Mathematics*, 118(3–4), 113–126. <https://doi.org/10.1111/ssm.12271>
- Cahyadi, R. A. H. (2019). Pengembangan Bahan Ajar Berbasis ADDIE Model. *Halaqa: Islamic Education Journal*, 3(1), 35–42. <https://doi.org/10.21070/halaqa.v3i1.2124>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the Role of Digital Technologies in Education: A Review. *Sustainable Operations and Computers*, 3(February), 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Hapsari, D. I. S., & Fahmi, S. (2021). Pengembangan Media Pembelajaran Interaktif Berbasis Android Pada Operasi Pada Matriks. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, 7(1), 51. <https://doi.org/10.24853/fbc.7.1.51-60>
- Hernandez-de-Menendez, M., Escobar Díaz, C. A., & Morales-Menendez, R. (2020).

- Educational Experiences with Generation Z. *International Journal on Interactive Design and Manufacturing*, 14(3), 847–859.
<https://doi.org/10.1007/s12008-020-00674-9>
- Hussein, M. H., Ow, S. H., Cheong, L. S., Thong, M. K., & Ale Ebrahim, N. (2019). Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review. In *IEEE Access*, (7), 62465–62478).
<https://doi.org/10.1109/access.2019.2916324>
- Indriyani, E., ES, Y. R., & Vahlia, I. (2021). Pengembangan Media Pembelajaran Matematika Berbasis Android Menggunakan Pendekatan Realistic Mathematics Education (RME). *EMTEKA: Jurnal Pendidikan Matematika*, 2(1), 1-10. <https://doi.org/10.32627/emteka.v2i1.313>
- Kartika, Y., Wahyuni, R., Sinaga, B., & Rajagukguk, J. (2019). Improving Math Creative Thinking Ability by using Math Adventure Educational Game as an Interactive Media. *Journal of Physics: Conference Series*, 1179(1).
<https://doi.org/10.1088/1742-6596/1179/1/012078>
- Kayan, S., & Aydin, Ş. (2023). The Effect of Teaching Algebraic Expressions with Educational Games on Sixth-Grade Students' Attitudes towards Mathematics. *International E-Journal of Educational Studies*, 7(15), 797–816.
<https://doi.org/10.31458/iejcs.1347251>
- Liu, Z. Y., Shaikh, Z. A., & Gazizova, F. (2020). Using the Concept of Game-Based Learning in Education. *International Journal of Emerging Technologies in Learning*, 15(14), 53–64. <https://doi.org/10.3991/ijet.v15i14.14675>
- Lopez, J. Y. A., Huaycho, R. N. N., & Santos, F. I. Y. (2023). The Impact of Serious Games on Learning in Primary Education: A Systematic Literature Review. *International Journal of Learning, Teaching and Educational Research*, 22(3), 379–395. <https://doi.org/10.1590/1983-3652.2025.51463>
- Pan, Y., & Mow, G. L. (2023). Study on the Impact of Gamified Teaching Using Mobile Technology on College Students' Learning Engagement. *International Journal of Emerging Technologies in Learning (IJET)*, 18(24), 133–148.
<https://online-journals.org/index.php/i-jet/article/view/45647>
- Pasrellia, R., & Disniarti. (2024). Teacher Strategies in Increasing Student Learning Interest with the Use of Science Lesson Image Media. *International Journal Education and Computer Studies (IJECS)*, 4(2), 57–63.
<https://doi.org/10.35870/ijecs.v4i2.3050>
- Permatasari, S., Asikin, M., & Dewi, N. R. (2022). MaTriG: Game Edukasi Matematika dengan Construct 3. *Indonesian Journal of Computer Science*, 11(1), 233–245. <https://doi.org/10.33022/ijcs.v11i1.3025>
- Rahayu, S. (2023). The Role of Interactive Technology in Inclusive Education: A Case Study. *International Journal of Educational Research Excellence (IJERE)*, 2(2), 542–552.
<https://ejournal.ipinternasional.com/index.php/ijere/article/view/643>
- Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math Anxiety: Past Research, Promising Interventions, and a New Interpretation Framework. *Educational Psychologist*, 53(3), 145–164.
<https://doi.org/10.1080/00461520.2018.1447384>
- Sahid, N. W., Prihaswati, M., & Mawarsari, V. D. (2024). Persepsi Siswa dan Guru SMP Terhadap Penggunaan Media Pembelajaran Matematika Berbasis

- Teknologi. *AKSIOMA: Jurnal Matematika Dan Pendidikan Matematika*, 15(1), 125–138. <https://doi.org/10.26877/aks.v15i1.18514>
- Sari, E. R., ES, Y. R., & Vahlia, I. (2021). Pengembangan Bahan Ajar Matematika Berbasis Android dengan Pendekatan Realistic Mathematics Education (RME) Materi Koordinat Kartesius. *EMTEKA: Jurnal Pendidikan Matematika*, 2(1), 61-72. <https://doi.org/10.32627/emteka.v2i1.318>
- Sitopu, J. W., Khairani, M., Roza, M., Judijanto, L., & Aslan. (2024). The Importance of Integrating Mathematical Literacy in the Primary Education Curriculum : a Literature Review. *International Journal of Teaching and Learning (INJOTEL)*, 2(1), 121–134. <https://injotel.org/index.php/12/article/view/54>
- Sugiarti, L., & Retnawati, H. (2019). Analysis of Student Difficulties on Algebra Problem Solving in Junior High School. *Journal of Physics: Conference Series*, 1320(1). <https://doi.org/10.1088/1742-6596/1320/1/012103>
- Sugiharti, A., Vahlia, I., & Rahmawati, D. (2025). Pengembangan Aplikasi Android Berbasis Problem Based Learning Berorientasi Kebudayaan Lokal Materi Baris Dan Deret Aritmatika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 14(2), 409-423. <https://doi.org/10.24127/ajpm.v14i2.9221>
- Tambunan, H., Sinaga, B., & Widada, W. (2021). Analysis of Teacher Performance to Build Student Interest and Motivation towards Mathematics Achievement. *International Journal of Evaluation and Research in Education*, 10(1), 42–47. <https://doi.org/10.11591/ijere.v10i1.20711>
- Umbara, U., Munir, Susilana, R., & Puadi, E. F. W. (2021). Algebra Dominoes Game: Re-Designing Mathematics Learning during the Covid-19 Pandemic. *International Journal of Instruction*, 14(4), 483–502. <https://doi.org/10.29333/iji.2021.14429a>
- Vahlia, I., Rahmawati, D., Mustika, M., Yunarti, T., & Nurhanurawati, N. (2021). Pengembangan E-Modul Aljabar Linear Berbasis Socrates Berbantu Aplikasi Android untuk Meningkatkan Keterampilan Berpikir Kritis dan Hasil Belajar Mahasiswa.
- Winarto, W., Rahmawati, D., & Vahlia, I. (2023). Pengembangan Bahan Ajar Gamifikasi Berbasis Contextual Teaching Learning (CTL) Berbantu Android. *EMTEKA: Jurnal Pendidikan Matematika*, 4(1), 141-152. <https://doi.org/10.32627/emteka.v4i1.1108>