https://doi.org/10.24036/jep/vol9-iss1/948

JEP (Jurnal Eksakta Pendidikan)
Volume 9, Issue 1, 1 – 17
ISSN: 2579-860X (Online), ISSN: 2514-1221 (Print)
https://jep.ppj.unp.ac.id/index.php/jep

Development of MESI GUNDA (Plane Shape Educational Game) Based on Android to Support Mathematical Problem-Solving Skills

Vita Arifatun*, Nina Agustyaningrum, Paskalia Pradanti
Mathematics Education, Universitas Tidar, Magelang, Indonesia.

Received: November 22th, 2024 ▪ Revised: May 18th, 2025 ▪ Accepted: May 19th, 2025

ABSTRACT

One of the skills that need to be given to students in learning mathematics is problem solving ability. However, at MTs N 5 Magelang, students' mathematical problem-solving ability is still low. In addition, the problem experienced is the lack of use of interactive learning media and using technology. The purpose of this research is to develop and analyze the validity, practicality, and effectiveness of Android-based MESI GUNDA (gaMe edukaSi banGun Datar or in English Plane Shape Educational Game) learning media to support mathematical problem-solving skills in flat building materials. This research is a type of Research and Development (RnD) with ADDIE model that utilizes Articulate Storyline, Canva, and WEB2APK Builder applications. The validity analysis used an assessment questionnaire from media and material experts consisting of two lecturers and one teacher for media experts, while material experts were carried out by one lecturer and two teachers. The practicality of the product was measured by a practicality questionnaire filled out by students and teachers totaling 27 students and one teacher, while the effectiveness by looking at the increase in pre-test and post-test scores of 23 students who were analyzed using N-gain. The results showed that Android-based MESI GUNDA media is valid, practical, and effective to support mathematical problem-solving skills. MESI GUNDA fulfills the valid aspect with a score of 90 out of 100 with a very valid category by media experts and from material experts obtained a score of 56 out of 65 with a very valid category. The media also meets the practical and effective aspects with a score of 80.59 out of 100 categorized as very practical and an N-gain value of 0.32 categorized as moderate. Therefore, the MESI GUNDA media is recommended for use by teachers to enhance the mathematical problem-solving abilities of junior high school students or their equivalents.

Keyword: Mathematical Problem-Solving Ability, Plane Shape, and MESI GUNDA

INTRODUCTION

Mathematics is one of the compulsory subjects taught at the primary and secondary education levels in Indonesia. This is in accordance with the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, Article 36, which emphasizes the importance of the curriculum in developing students' competencies. One of the key competencies in mathematics learning is problem-solving ability (Hartawan et al., 2024).

***Correspondence:**
Vita Arifatun, Mathematics Education, Universitas Tidar, Magelang, Indonesia.
✉ email: vitaarifatun031@gmail.com

Problem solving in the context of mathematics has been defined by many experts. According to Polya (1957), problem solving is a thinking process aimed at finding a way out of a difficulty or achieving an unknown goal through systematic steps. Tanjung et al. (2024) reinforces this definition by stating that problem solving is a fundamental skill for addressing issues by making the right decisions and involves critical and systematic thinking. In addition, Santosa (2023) argues that problem solving is an essential component of mathematics, as it allows students to practice and develop mathematical skills, such as applying rules to unsolved problems, discovering new ways to combine ideas, and communicating understood mathematical concepts.

In practice, indicators of problem-solving ability have also been developed by many researchers. Paucar-Curasma et al. (2024) proposed four stages of problem solving: understanding the problem, planning a solution strategy, implementing the strategy, and reviewing the results obtained. Meanwhile, Mahanal et al. (2022), in her research, used a problem-solving process that includes reading the problem, identifying the problem, constructing a solution, solving the problem, reviewing the solution, and extending the solution. Rott et al. (2021) also outlined five stages of mathematical problem-solving ability: understanding the problem, analyzing the problem, planning the solution, implementing the plan to find a solution, and reflecting. Based on these studies, this research uses problem-solving indicators that refer to the theory proposed by Polya (1957). The four indicators include understanding the problem, devising a plan, carrying out the plan, and checking or reflecting on the results obtained.

In the context of mathematics education, one important branch of knowledge is geometry (Nazarovich & Kurudirek, 2024). One of the topics in this branch is flat shapes. However, many students face difficulties in solving problems related to flat shapes, as evidenced by the results of a needs analysis. This analysis was conducted by distributing questionnaires to 39 students and 2 teachers, as well as conducting interviews with 5 students and 1 teacher at MTs N 5 Magelang. The findings from the questionnaires and interviews indicate that many students struggle to understand and solve problems involving combinations of multiple flat shapes. Another difficulty is translating word problems into more formal mathematical language. This is reflected in the results of daily assessments, which show that the average student score is only 53.23%, with 92.31% of students not meeting the Minimum Completeness Criteria.

A factor contributing to the low problem-solving ability is the lack of motivation among students to learn mathematics. This aligns with Wawan and Retnawati (2022), who states that students' learning motivation can influence the improvement of their mathematical problem-solving skills. One approach considered effective in enhancing both motivation and problem-solving ability is the use of interactive and technology-based learning media. This is supported by research findings from Indu and Djara (2025) which indicate that interactive and technology-based learning media can increase students' motivation and problem-solving skills. However, based on the questionnaire results, most students reported that the use of learning media in teaching and learning activities is still very limited, confined to assessments through applications like Quizizz or using search engines to find learning resources.

Gadgets can help obtain information more quickly. Additionally, instructors can utilize Android-based gadgets as a medium for delivering learning materials. The use of gadgets is necessary in mathematics learning, as 80% of the students interviewed believe that mathematics is a boring subject. The use of Android-based gadgets can be one way to make

students more interested in the mathematics learning process. This is in line with research conducted by Djumingin et al. (2021), which reported a positive and significant relationship between the use of gadgets and students' interest in learning. Moreover, the study recommends utilizing gadgets in the learning process as a fun medium. The learning process has not yet fully integrated technology, so there is a need for a medium that reflects current technology, one of which is the use of educational games. Educational game-based learning media are effective in supporting mathematical problem-solving skills (Qotrunada & Furqon, 2024).

Based on the issues regarding students' mathematical problem-solving abilities and the use of learning media, this study aims to develop an educational game learning media called MESI GUNDA (gaMe edukaSi banGun Datar) that can be accessed through gadgets. The developed media not only presents problems in the form of a game but also includes materials and example problems based on contextual issues. This development is motivated by the results of a needs analysis questionnaire, which showed that 94.87% of students need more engaging and varied alternative learning media, and 100% of students agree that an Android-based educational game learning media called MESI GUNDA (gaMe edukaSi banGun Datar) would be useful for teaching plane shape s in mathematics. The development of this media uses an application called Articulate Storyline, along with other supporting applications, such as Canva and Web2APK Builder. Articulate Storyline is a platform that combines several types of media into a single interactive application (Daryanes et al., 2023). This software can help create interactive applications. The resulting application can be used as a learning media to increase students' interest in participating in the learning process, particularly in mathematics. However, to convert the files created in Articulate Storyline into an app, a third-party or helper application is required. This application is Web2APK Builder.

Previous studies have produced educational games that only feature games (Phoong & Yaakub, 2024; Qohar et al., 2021). Additionally, there are studies that resulted in an educational game application accessible via PC (Personal Computer) (Okty et al., 2022; Widjaja et al., 2024). This study aims to develop an educational game that offers novelty compared to existing research. The novelty is that the educational game, named MESI GUNDA, includes both learning materials and games, and can be accessed through smartphones. Based on the explanation provided, this study aims to describe the validity, practicality, and effectiveness of the MESI GUNDA (gaMe edukaSi banGun Datar) Android-based learning media in supporting students' mathematical problem-solving abilities in the topic of plane shape s.

METHOD

Research Design

This research is classified as a type of Research and Development (RnD) study. The Research and Development (RnD) method is a research approach used to produce a specific product and test the effectiveness of that product (Waruwu, 2024).This study develops a product called MESI GUNDA (gaMe edukaSi banGun Datar). MESI GUNDA can be used as an engaging learning media in the form of an educational game application that can be accessed on smartphones with an Android operating system. The model used in this research is ADDIE. The ADDIE development model consists of five stages or steps (Latif & Nor, 2020), which include Analysis, Design, Development or Production, Implementation, and Evaluation.

Figure 1. Development Flow with the ADDIE Model

The analysis phase is carried out through a literature review and a field study. The literature review involves searching for relevant articles based on the variables used, while the field study is conducted through observations, questionnaire distribution, and interviews at MTs Negeri 5 Magelang. The design phase involves creating a storyboard and flowchart for the development process, as well as designing the learning media. The development phase includes the realization of the product design that was created earlier, using applications such as Articulate Storyline, Canva, and Web2APK. The implementation phase is carried out by implementing the application with students and administering a questionnaire to measure the practicality of the product. In addition, during the implementation phase, pre-test and post-test questions are given to assess the effectiveness of the product. The evaluation phase aims to gather feedback from the product users, which allows for improvements based on the evaluation results or unmet needs. The evaluation in this study is conducted by assessing the phases that have been implemented and evaluating the developed product to determine its validity, practicality, and effectiveness. The flowchart can be seen more clearly in Figure 2.

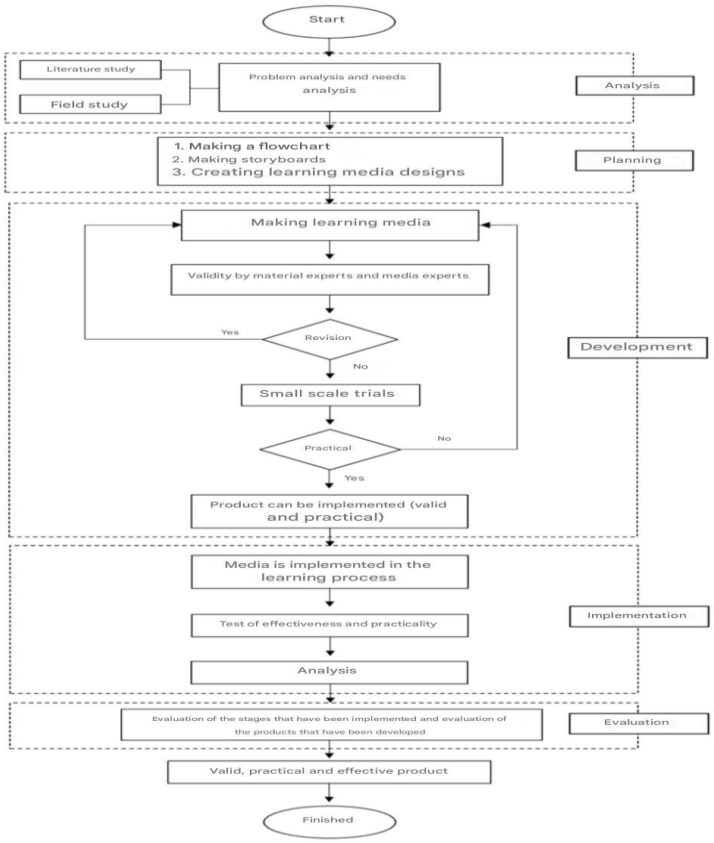

Figure 2. Flowchart diagram of the MESI GUNDA development

Participants

This study used the seventh-grade students of MTs N 5 Magelang as the population. The seventh grade at MTs N 5 Magelang consists of 11 parallel classes, which are considered to have similar characteristics. Since the trial was limited in scope, one class was selected as the sample. The sample selection was carried out randomly by drawing lots. The class chosen as the sample was class VII P1, which consists of 26 students. This class will be used as the experimental group (the class using the MESI GUNDA learning media). The sampling method used is cluster random sampling. Additionally, there is a limited test subject group consisting of eight students, selected using simple random sampling.

Instruments

Data collection techniques were carried out through interviews, observations, questionnaires, and written tests. The instruments used include a validation sheet to assess the validity of the product, which is given to media and content experts as validators. The material and media validators were mathematics education teachers and lecturers with an academic background in mathematics and a history of teaching courses related to mathematics learning. In addition, they also serve as lecturers and teachers for courses in media or multimedia. The instrument for the practicality test is a practicality questionnaire filled out by students and teachers, while the effectiveness test uses mathematical problem-solving ability questions (pre-test and post-test) in the form of written responses completed by the students. Additionally, an observation sheet was created to assess the implementation of the learning process.

Data Analyis

The data obtained were then analyzed using descriptive statistical methods. Data analysis for validity and practicality tests employed categorization adapted from (Fatimah et al., 2021). The categories for validity and practicality tests used can be seen in Table 1. The developed media is considered valid or practical if the assessment from the validators is at least in the valid/practical category (Mahardika et al., 2022).

Table 1. Categories of Media Validity and Practicality

Kategori	Interval Nilai
Very Valid/Practical	$M_i + 1{,}5S_i < X$
Valid/Practical	$(M_i + 0{,}5S_i) < X \leq (M_i + 1{,}5S_i)$
Quite Valid/Practical	$(M_i - 0{,}5S_i) < X \leq (M_i + 0{,}5S_i)$
Less Valid/Practical	$(M_i - 1{,}5S_i) < X \leq (M_i - 0{,}5S_i)$
Not Valid/Practical	$X \leq M_i - 1{,}5S_i$

Description:
X = Total Actual Score
M_i= Average Ideal Score: $\frac{1}{2}(score\ maksimum + score\ minimum)$
S_i= Ideal Standard Deviation: $\frac{1}{2}(score\ maksimum - score\ minimum)$

The effectiveness test uses a written test in the form of a one-group pretest-posttest design, with the categorization of N-gain. However, before the categorization is conducted, the data must be confirmed as normally distributed using the Liliefors method. Once the data is confirmed to be normally distributed, the N-gain test is carried out. This test is performed

by examining the improvement in pre-test and post-test scores using the formula and N-gain categorization adopted from (Setiawan et al., 2024), as shown in the following formula.

$$N - gain(g) = \frac{x_2 - x_1}{x_{maks} - x_1}$$

Description:
x_1 = score *pre-test*
x_2 = score *post-test*
x_{maks} = score maksimal

After the N-gain scores are obtained, the N-gain score categorization is then examined to assess the improvement in students' mathematical problem-solving abilities. Table of N-gain score categories can be seen in Table 2. The media is considered effective if the improvement in pre-test and post-test scores is at least in the medium category (Nurhusain, 2021).

Table 2. Category *N-gain Score*

N-gain score	**Kategori**
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Medium
$g < 0{,}3$	Low

RESULTS AND DISCUSSION

Results

This study developed an Android-based educational game called MESI GUNDA (gaMe edukaSi banGun Datar) to enhance students' mathematical problem-solving skills in the topic of flat shapes. The development used Articulate Storyline, Web2APK Builder, and Canva, following the ADDIE model. Based on the research that has been conducted, the following results were obtained.

Analysis Stage

The main objective of this stage is to analyze the problems that occur and conduct a needs analysis to support the resolution of the issues faced. The analysis stage was carried out through field studies and literature reviews. Through both the field study and literature review, it was found that students were less interested and faced difficulties in mathematical problem-solving, particularly in the topic of flat shapes. Based on these findings, an interactive and technology-based Android learning media called MESI GUNDA (gaMe edukaSi banGun Datar) was developed to enhance students' interest and understanding of the material

Design Stage

The design stage includes activities such as creating a flowchart, storyboard, and the design of the learning media. The flowchart serves as a guide for developing the MESI GUNDA media from start to finish. The storyboard contains the design of the content and structure of the media to ensure a well-organized development process. The media design is carried out using Articulate Storyline and Canva for the content and objects, and then converted into an APK format using Web2APK Builder after being exported in HTML.

Development (or Production) Stage

This stage involves activities such as creating instruments, developing the media, and conducting validity and practicality tests on a small scale. The instrument development process includes creating tools for validity (questionnaires), practicality (questionnaires), and product effectiveness (ability tests in the form of pre-tests and post-tests). The next stage is the media creation stage. This stage is the realization of the media development based on the storyboard that was previously designed. The result of this media creation is the interface displayed in MESI GUNDA. An example of the display featured in the MESI GUNDA media can be seen in Figure 3.

Figure 3. Loading Screen

Based on Figure 3. the loading screen features a progress bar that indicates the process of entering MESI GUNDA, along with the MESI GUNDA logo. As can be seen in Figure 3, MESI GUNDA stands for "Game Edukasi Bangun Datar," which translates to "Plane Shape Educational Game" in English. MESI GUNDA logo also serves as the MESI GUNDA icon once it has been successfully installed on the smartphone. Furthermore, Figure 4 shows the login page.

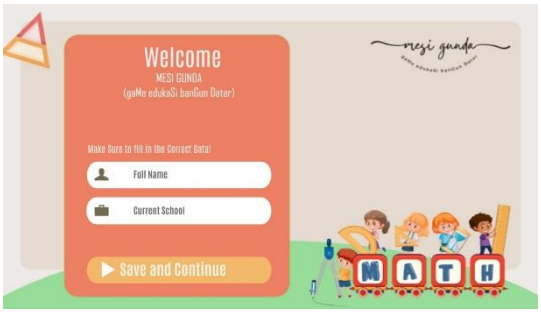

Figure 4. Login Screen

Figure 4. shows the login page, which includes fields for the name and school origin. Both fields must be filled in by the MESI GUNDA user and cannot be left empty. After successfully logging in, the main menu will be displayed, as shown in Figure 5.

Figure 5. Main Menu Display

Figure 5 is a snapshot of the main menu display that appears after the user successfully logs in. This display contains two main menus: Learn and Play. The Play menu is used to start the games available in MESI GUNDA. The Learn menu includes five main options: TP (Learning Objectives), ATP (Learning Objectives Flow), triangle, quadrilateral, and circle. When the user presses one of the buttons triangle, quadrilateral, or circle a sample problem will be displayed first before proceeding to the material. After completing the problem, the solution to that problem will then be presented. An example of this display can be seen in Figure 6.

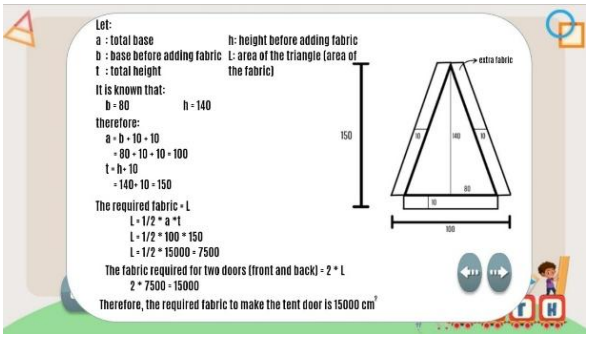

Figure 6. Problem Solving Display on Sample Questions

MESI GUNDA provides sample questions along with solutions for each subtopic. Figure 6 is an example of the problem-solving display for the triangle subtopic. This display appears before entering the triangle material. The sample question presented includes real-life problems, while the solution is designed according to problem-solving ability indicators. This approach is also applied to other subtopics, such as quadrilaterals and circles. Meanwhile, when the user presses the "Play" button, the level selection screen will appear, as shown in Figure 7.

Figure 7. Game Level Display

Figure 7 is the cover display of each level, showing only Level 1 as open. Each level will unlock once the user has completed the previous level. MESI GUNDA contains 9 levels, with each level having a different degree of difficulty. There are several problems that include indicators of problem-solving skills, one of which is the problem found in Level 8. Level 8 is shown in Figure 8.

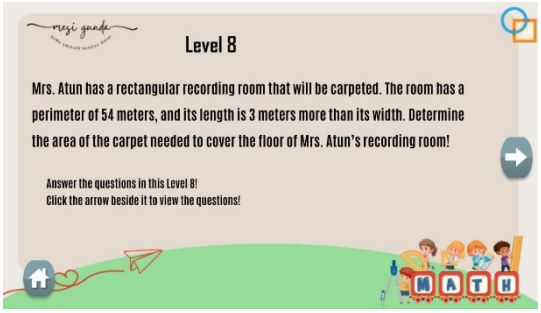

Figure 8. Level 8 Display

Figure 8 is an example of a level in the game featured in MESI GUNDA. Based on Figure 8, which shows the Level 8 game display, it is clear that this level contains problem-solving questions. Level 8 consists of several stages that appear when the arrow icon is clicked. These stages include indicators for mathematical problem-solving abilities. The user is required to complete all stages accurately. The final stage contains a button to submit the answer and view the score earned for Level 8.

After the media has been successfully created, the next step is to test the validity of the product, which is conducted by content experts and media experts. The media expert validators consist of 2 lecturers and 1 teacher, while the content expert validators are 1 lecturer and 2 teachers who are specialists in their field. The validation results can be seen in Table 3.

Tabel 3 Validation Test Results

Validation	Validator	Score	Average Score	Category
Media Expert	1	94	90	Very Valid
	2	79		
	3	97		
Content Expert	1	53	56	Very Valid
	2	54		
	3	61		

The validators provided suggestions for improvements to the MESI GUNDA media. The researcher has addressed some of the suggestions, but has not yet been able to fully implement the suggestion from Validator 3, who is a content expert. This suggestion proposed that the material should not be directly presented in its final form, but rather that students should be encouraged to discover or construct the material on their own. Although this suggestion would help in student understanding, the limitations of the app size posed a challenge for the researcher in fully implementing this recommendation.

The final activity in the design stage is a small-scale practicality test. This test is aimed at measuring the practicality of the developed media before it is implemented. A limited trial

was conducted with eight students from class VIII who had already studied the topic of flat shapes. The participants carried out three activities: installing the MESI GUNDA media application on their smartphones, exploring the content of the media, and completing a practicality questionnaire. The results of the small-scale practicality test are shown in Table 4

Tabel 4 Small-Scale Practicality Test Results

Aspect	Score	Persentase
Media Display	31,75	79,38%
Media Content	50,63	84,38%
Total Score	82,28	
Category	Very Practical	

The participants provided suggestions for improvements through the questionnaire, including the issue of music that continues to play after exiting the application. The researcher has attempted to address this issue based on the suggestions, but has encountered difficulties in identifying the cause, and thus, no definitive solution has been found. One of the efforts made was to clear the app's activity history in order to stop the music from playing continuously.

Implementation Stage

The implementation stage of the MESI GUNDA media product was carried out in class VII P1 at a school in Magelang Regency. The implementation took place over four sessions, using direct instruction for the topic of flat shapes (triangle and quadrilateral). The process began with administering a pre-test to the students before using the learning media. After that, they were provided with the material and completed the game within the media. Once the activities were completed, the students were given a post-test. The results of the pre-test and post-test were used to evaluate the effectiveness of the media. Before the scores were used to assess the effectiveness of the media, the data had to be confirmed as normally distributed. The results of the normality test analysis, using the Lilliefors method and Microsoft Excel for calculations, can be seen in Table 5. After the data is confirmed to be normally distributed, the next step is to conduct the N-gain test. The results of the data calculation using the formula and categorization adopted from (Setiawan et al., 2024) are shown in Table 6. The practicality test was also conducted during the implementation stage. This test was carried out by giving a questionnaire to the students and the teacher after using the MESI GUNDA media. The results of the practicality questionnaire analysis can be seen in Table 7.

Tabel 5 Normality Test Results

Test	L_{hitung}	L_{tabel}	Kriteria
Pre-test	0,124	0,192	Normal
Post-test	0,143	0,192	Normal

Tabel 6 *N-gain* Test Results

Average *N-gain*	Category
0,32	Medium

Tabel 7 Practicality Questionnaire Analysis Results

Aspect	Score	Persentase
Media Display	32,56	81,4%
Media Content	48,04	80,1%
Total Score	80,59	
Category	Very Practical	

Evaluation Stage

This stage is carried out by evaluating each phase that has been completed, as well as evaluating the developed product. The evaluation concludes when the product is declared valid, effective, and practical. The evaluation in the analysis stage focuses on solutions that address the problems and needs of the students, specifically the development of an Android-based learning media called MESI GUNDA (gaMe edukaSi banGun Datar) to support mathematical problem-solving skills. The evaluation in the planning or design stage aims to improve the media design, including the structure, elements, or content used, based on the suggestions provided by the advisor.

Evaluation in the development (or production) stage focuses on improvements suggested by validators, both media experts and content experts, as well as based on the results of the small-scale trial. In the implementation stage, evaluation is conducted by focusing on the results of the mathematical problem-solving ability test and the questionnaire responses. The final evaluation is carried out in the data analysis stage, which includes validity tests, practicality tests, and effectiveness tests, to determine whether the developed media is valid, practical, and effective.

Discussion

MESI GUNDA is an acronym for gaME edukaSI banGUN DAtar, an Android-based educational game that can be used as a learning media to support students' mathematical problem-solving skills, particularly in the topic of flat shapes. The media was developed using the ADDIE model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation (Latif & Nor, 2020), using Articulate Storyline and other supporting applications, such as Canva and Web2APK Builder. An instructional media that is developed must meet the standard criteria of validity, practicality, and effectiveness in order to be considered suitable for use (Syafmen & Indri, 2023). Therefore, to ensure the quality of the MESI GUNDA media, it underwent several tests, including validity, practicality, and effectiveness tests. The following is a detailed explanation of the results from these tests.

Product Validity

The purpose of product validity is to assess how valid the developed media is for use as a learning tool (Panjaitan et al., 2020). Product validity involves two activities: validity testing by media experts and content experts. The validation by media experts was carried out by 1 teacher and 2 university lecturers, while the validation by content experts was conducted by 1 lecturer and 2 teachers.

The validation by media experts shows that the MESI GUNDA media meets three main aspects: media appearance, language use, and media design principles. The assessment by media experts indicates that MESI GUNDA has consistent and harmonious design, colors,

elements, templates, fonts, font sizes, and layout proportions. Additionally, the media contains high-resolution images, making the developed media visually appealing. One of the requirements for media to be considered valid is to meet the language appropriateness aspect (Harahap & Siddiq, 2022). The language used in MESI GUNDA follows the rules of effective sentence structure and the Indonesian Spelling System (EYD), without ambiguity, making it easy to understand. Moreover, the use of mathematical terms and symbols adheres to established standards. Therefore, MESI GUNDA meets the validity requirements in terms of language use. The developed media also meets the principles of media design, as it features an attractive design that reflects creativity. Furthermore, it includes menus and usage instructions that are easy to understand, making MESI GUNDA user-friendly. MESI GUNDA, which is Android-based, is an interactive and technology-based learning media, as it provides feedback for each answer given and can be accessed through smartphones. Educational games can be implemented in future learning processes, according to research conducted by Izat et al. (2025), which concluded that electronic educational games can be used in the future. Therefore, it can be concluded that MESI GUNDA can also be applied to future learning processes.

The validation by content experts serves to assess the alignment of the material contained in the media with the syllabus or learning objectives (Liniasari et al., 2021). The validation questionnaire by content experts includes aspects of the material, language use, and the structure of the content. MESI GUNDA is valid in terms of its content, as evidenced by the validation results, which show that the material used is accurate and aligns with the Learning Objectives (TP), Learning Pathways (ATP), and the needs of the students. This media also contains illustrations that support understanding and uses language that adheres to the Indonesian Spelling System (EYD), ensuring there are no ambiguities and that it is easy to comprehend.

The MESI GUNDA media also supports mathematical problem-solving skills by presenting questions or problems that implement indicators of mathematical problem-solving abilities. Based on the results of the questionnaire, MESI GUNDA is considered suitable for independent learning by students, and the structure of the material presented is systematic.

The developed media is considered valid if the assessment from the validators is at least in the valid category. Validation by media and content experts shows that MESI GUNDA falls into the very valid category, with an actual score of 90 for media expert validation and an actual score of 56 for content expert validation. Therefore, the MESI GUNDA (gaMe edukaSi banGun Datar) Android-based media is considered to meet the product validity requirements.

Product Practicality

MESI GUNDA (gaMe edukaSi banGun Datar) was developed for seventh-grade students and can be accessed via an Android-based smartphone. The practicality of a product can be assessed based on five components: ease of use, media interpretation, time efficiency, equivalence, and product appeal (Rizqa et al., 2023). The ease of using the media is supported by clear instructions and menus that are easy to understand and apply. This is evident in MESI GUNDA, with 80.77% of students stating that the media contains menus and instructions that are easy to understand and apply. One benefit of the media, according to Firman et al. (2022), is its time and energy efficiency. This is because the media helps students better understand the material, thus reducing the time and effort required. MESI GUNDA also aids students in comprehending the material, as confirmed by 84.6% of the students who filled out the survey, indicating that the media helped them understand the geometry material more easily.

A learning media can be used effectively in education if the language used is easy to understand and follows the correct rules, ensuring that it does not lead to misinterpretation. MESI GUNDA is a learning media with language that is easy to understand and follows the Indonesian Spelling System (EYD), as confirmed by 100% of the respondents who agreed with this statement. The practicality of the media can also be seen from its product appeal. This media also has an attractive design, which is liked by 84.6% of the students who filled out the survey. Based on the research conducted by Liu et al. (2021), it was stated that educational games can increase students' enthusiasm for learning. This is in line with the survey results, which found that 88.5% of students felt more interested in learning mathematics when using the MESI GUNDA media. This media is also engaging due to its use of visual images and color combinations.

MESI GUNDA, an Android-based platform, reflects an interactive and technology-based learning media that can support students' mathematical problem-solving skills. One of the evidence of the media's interactivity is the inclusion of interactive activities such as direct input, selecting the correct answer, matching items, and drag-and-drop exercises. Additionally, this media provides feedback for every answer submitted. The feedback can include statements of correctness (right or wrong) and the display of the score earned. Interactive multimedia can be used for self-directed learning (Daryanes et al., 2023). Therefore, MESI GUNDA can also be utilized for independent learning, as supported by the 96.2% of students who agreed with this statement.

The developed media not only contains practice questions but also includes comprehensive material on plane geometry, along with example problems and their solutions. According to a statement from the mathematics teacher, this media can be used to explain the material, thus assisting the teacher. In addition to helping teachers explain the content, the MESI GUNDA media can also support students' mathematical problem-solving skills. This is because the media includes indicators of mathematical problem-solving ability, both in the example problems and the games (practice questions).

The developed media is considered practical if the evaluation results from students and teachers who complete the practicality questionnaire are at least in the practical category (Mahardika et al., 2022). The Android-based MESI GUNDA (gaMe edukaSi banGun Datar) media received a score of 80.59, which falls under the very practical category. Therefore, the Android-based MESI GUNDA (gaMe edukaSi banGun Datar) media meets the criteria for product practicality.

Effectiveness of the Product

Educational games can improve students' mathematical problem-solving skills (Lukman et al., 2023). The effectiveness of the product can be measured by comparing the improvement in pre-test and post-test scores using N-gain (Wiwin, 2021). MESI GUNDA has been proven effective based on the analysis of pre-test and post-test scores using N-gain, with an improvement of 0.32, which falls into the moderate category. This aligns with the opinion (Nurhusain, 2021) that a developed media is considered effective if the improvement in pre-test and post-test scores is at least in the moderate category.

MESI GUNDA contains problems that are relevant to everyday life to train students' mathematical problem-solving skills. This media also applies problem-solving ability indicators through practice exercises and example problems. The average N-gain obtained falls into the moderate category, indicating that the media is effective. Therefore, the media can be considered effective in supporting students' mathematical problem-solving abilities.

The implementation of the Android-based MESI GUNDA media has increased students' enthusiasm for learning mathematics. This is because the media can be accessed through smartphones, reflecting a technology-based learning tool. In addition to being technology-based, MESI GUNDA is also interactive. One of the characteristics of interactive learning media is its ability to accommodate responses from users (Nurul et al., 2025). In addition, interactive learning media should also serve the function of allowing users to participate by providing feedback, such as offering multiple-choice answers that users can select and giving responses to the answers provided (Moreno & Pineda, 2020). MESI GUNDA contains example problems that must be answered before the solutions are revealed. Feedback is provided for the answers given, and users can view the correct answers or answer keys, which are also available in the MESI GUNDA game menu.

Based on the results of the effectiveness test conducted, it can be concluded that the MESI GUNDA media is effective for use in the learning process, with an N-gain improvement value of 0.32, categorized as moderate. Furthermore, the developed media is also effective in supporting students' mathematical problem-solving abilities. This is because MESI GUNDA includes all the indicators of problem-solving skills, and the results from the pre-test, game, and post-test completed by students show that each indicator of mathematical problem-solving ability has improved.

As explained in the previous sections, the results show that the MESI GUNDA (gaMe edukaSi banGun Datar) Android-based media has met all the research objectives, including validity testing, practicality testing, and effectiveness testing. Therefore, it can be concluded that the MESI GUNDA Android-based media is valid, practical, and effective. Furthermore, the use of the MESI GUNDA (gaMe edukaSi banGun Datar) media can support students' mathematical problem-solving abilities. This is because both the example problems and the practice questions (games) included in the media contain indicators of mathematical problem-solving skills.

MESI GUNDA has advantages over other educational games, namely that it includes lessons along with example problems and their solutions. This media also contains practice problems designed as games, which serve to enhance students' motivation to learn and solve mathematical problems, particularly problem-solving questions. Additionally, MESI GUNDA provides feedback on every answer given, including warnings or statements indicating whether the answer is correct or incorrect, and is accompanied by answer keys. However, there are still areas that need improvement in this media. MESI GUNDA is unable to provide answer keys for all levels. Levels 1 and 3 do not include answer keys, so the researcher hopes that future studies can address this limitation.

CONCLUSION

Based on the results of the study, it can be concluded that the MESI GUNDA (gaMe edukaSi banGun Datar) Android-based media is valid, practical, and effective in supporting students' problem-solving skills in the flat geometry material for grade VII. This is evidenced by the validity score of 90, categorized as highly valid by the media expert, while the content expert obtained a score of 56, also categorized as highly valid. The media is practical, with a questionnaire score of 80.59, categorized as highly practical. Furthermore, the media is effective, with an N-gain score of 0.32, categorized as moderate. The results of this study imply the importance of using technology-based mathematics learning media to stimulate students' problem-solving abilities.

However, the media developed in this study still has several limitations. Among them are the limited practicality and effectiveness testing conducted in the classroom. Further trials on a larger scale are needed to evaluate the media's effectiveness. Additionally, this media can currently only be accessed on Android smartphones. Future research could focus on developing an application that is compatible with other operating systems, such as iOS.

REFERENCES

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, I., Rusandi, M. A., & Situmorang, D. D. B. (2023). The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability. *Heliyon*, *9*(4), e15082. https://doi.org/10.1016/j.heliyon.2023.e15082

Djumingin, S., Weda, S., & Maman, M. (2021). The Relationship Between the Use of Gadgets and Students' Interest in Learning Literature at Higher Education in Indonesia. *Turkish Journal of Computer and Mathematics Education*, *12*(14), 5896–5912.

Fatimah, S., Mahmudah, M., & Aisyah, N. (2021). Development of Multimedia Focusky-Based Comic Media on Natural Science Learning for Students Class V in Elementary School. *JIP Jurnal Ilmiah PGMI*, *7*(1), 69–75. https://doi.org/10.19109/jip.v7i1.8846

Firman, F., Alef, R., & Eric, M. (2022). Use Of Zoom Meeting Applications to Memorize the Qur'an Online. *Journal International Inspire Education Technology*, *1*(2), 99–110. https://doi.org/10.55849/jiiet.v1i2.92

Harahap, M. P., & Siddiq, N. E. A. N. K. H. A. (2022). Validity of Computer Based Learning Media to Improve Junior High School Students' Learning Outcomes on Ecosystem Topics. *Journal of Science and Technological Education*, *1*(1), 2830–4829. www.meta.amiin.or.id

Hartawan, I. G. N. Y., Suharta, I. G. P., Sudiarta, I. G. P., & Pujawan, I. G. N. (2024). Student Problem Solving Ability in Mathematics Learning: Systematic Literature Review. *International Journal of Religion*, *5*(11), 3030–3037. https://doi.org/10.61707/sm1dtc57

Indu, N. A. Y., & Djara, J. I. (2025). *Use Of Computer-Aided Interactive Multimedia Learning Media To Increase Learning Motivation And Mathematics Problem Solving Ability*. *4*(1), 40–48.

Izat, M., Kyyakbayeva, U., Nurgaliyeva, S., Urinova, F., & Khallokova, M. (2025). The implications of educational games on the development of children's intellectual abilities. *International Journal of Innovative Research and Scientific Studies*, *8*(1), 126–136. https://doi.org/10.53894/ijirss.v8i1.3578

Latif, R. A., & Nor, M. Z. M. (2020). Using the addie model to develop a rusnani concept mapping guideline for nursing students. *Malaysian Journal of Medical Sciences*, *27*(6), 115–127. https://doi.org/10.21315/mjms2020.27.6.11

Liniasari, A. A. A. M., Yudiana, K., & Dibia, I. K. (2021). Comic-Based Learning Media with the Topic of Natural Resources. *International Journal of Elementary Education*, *5*(1), 80. https://doi.org/10.23887/ijee.v5i1.34327

Liu, F., Vadivel, B., Rezvani, E., & Namaziandost, E. (2021). Using Games to Promote English as a Foreign Language Learners' Willingness to Communicate: Potential Effects and Teachers' Attitude in Focus. *Frontiers in Psychology*, *12*(October), 1–10. https://doi.org/10.3389/fpsyg.2021.762447

Lukman, H. S., Agustiani, N., & Setiani, A. (2023). Gamification of Mathematics Teaching Materials: Its Validity, Practicality and Effectiveness. *International Journal of Emerging Technologies in Learning (IJET)*, *18*(20), 4–22. https://doi.org/10.3991/ijet.v18i20.36189

Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering

College Students' Problem-Solving Skills through RICOSRE. *Education Sciences*, *12*(3). https://doi.org/10.3390/educsci12030196

Mahardika, A. I., Purba, H. S., & Permana, A. (2022). The Development of Web-Based Interactive Learning Media on Static Electricity Materials With Tutorial Model. *Physics Education Journal*, *5*(1), 1–18. https://journalfkipunipa.org/index.php/kpej/article/view/220

Moreno, J., & Pineda, A. F. (2020). A Framework for Automated Formative Assessment in Mathematics Courses. *IEEE Access*, *8*(February), 30152–30159. https://doi.org/10.1109/ACCESS.2020.2973026

Nazarovich, S. T., & Kurudirek, A. (2024). An Overview of Existing Problems in Teaching the Science "Fundamentals of Geometry". *International Journal of Social Sciences & Educational Studies*, *11*(2), 91–106. https://doi.org/10.23918/ijsses.v11i2p91

Nurhusain, M. (2021). Efektivitas model kooperatif Tipe rotating trio exchange dalam pembelajaran logaritma. *Journal of Honai Math*, *4*(1), 19–34.

Nurul, A., Wardani, S., & Widiyatmoko, A. (2025). Development of Interactive Web Media Based On Differentiated Learning to Improve Mastery of Respiratory System Material and Learning Independence of Elementary School Students. *International Journal of Multidisciplinary and Current Educational Research (IJMCER*, *7*(2), 32–43.

Okty, W., Amir, M., & Lumowa, S. V. T. (2022). Development of Computer-based Educational Game " Blood Circulation " as Learning Media for Science Biology for Class VIII Junior High School. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, *4531*, 69–78.

Panjaitan, R. G. P., Titin, T., & Putri, N. N. (2020). Multimedia interaktif berbasis game edukasi sebagai media pembelajaran materi sistem pernapasan di kelas XI SMA. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *8*(1), 141–151. https://doi.org/10.24815/jpsi.v8i1.16062

Paucar-Curasma, R., Villalba-Condori, K. O., Gonzales-Agama, S. H., Huayta-Meza, F. T., Rondon, D., & Sapallanay-Gomez, N. N. (2024). Technological Resources and Problem-Solving Methods to Foster a Positive Attitude Toward Formative Research in Engineering Students. *Education Sciences*, *14*(12). https://doi.org/10.3390/educsci14121397

Phoong, S. Y., & Yaakub, N. F. (2024). Development and Usability of Games in Learning Mathematics. *International Journal of Learning and Teaching*, *10*(2), 218–222. https://doi.org/10.18178/ijlt.10.2.218-222

Qohar, A., Susiswo, Nasution, S. H., & Wahyuningsih, S. (2021). Development of Android-Based Mathematics Learning Game on the Topic of Congruence and Similarity. *IJIM International Journal: Interactive Mobile Technologies Papers*, *15*(09), 52–69.

Qotrunada, A., & Furqon, S. (2024). Development of Interactive Game-Based Learning Media Using Realistic Approach to Improve Students' Mathematical Problem-Solvingin Social Arithmetic Materials for Grade VII. *International Journal of Research in Mathematics Education*, *2*(1), 79–104. https://doi.org/10.24090/ijrme.v2i1.11466

Rizqa, M., Husni, R., & Rahmi, U. (2023). the Development of Interactive Multimedia Learning in Vocational School. *Mathematics Research and Education Journal*, *7*(2), 14–24. https://doi.org/10.25299/mrej.2023.vol7(2).14496

Rott, B., Specht, B., & Knipping, C. (2021). A descriptive phase model of problem-solving processes. *ZDM - Mathematics Education*, *53*(4), 737–752. https://doi.org/10.1007/s11858-021-01244-3

Santosa, A. B. (2023). Application of Problem-Solving Learning to Improve Mathematics Learning Outcomes in Elementary Schools. *Pedagogika*, *14*(2), 209–220.

Setiawan, D. G. E., Kuengo, N. R., Supartin, S., Arbie, A., Paramata, D. D., & Ntobuo, N. E. (2024). The Influence of The PjBL Model Based on Local Gorontalo Cultural Values to The Learning Outcomes in Simple Aircraft Concepts. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1417–1425. https://doi.org/10.29303/jppipa.v10i3.6933

Syafmen, W., & Indri, S. (2023). Development of M-Learning Media Illustrated Crossword Puzzles to Increase Learning Motivation for Middle School Students. *Journal of Educational Science and Technology (EST)*, *9*(2), 111. https://doi.org/10.26858/est.v9i2.44064

Tanjung, Y. I., Festiyed, Diliarosta, S., Jubaidah, & Sanjaya, A. P. (2024). Analysis of Students' Problem Solving Skills based on Heller Indicator. *Pegem Journal of Education and Instruction*, *14*(4), 421–433. https://doi.org/10.47750/pegegog.14.04.40

Waruwu, M. (2024). Metode Penelitian dan Pengembangan (R&D): Konsep, Jenis, Tahapan dan Kelebihan. *Jurnal Ilmiah Profesi Pendidikan*, *9*(2), 1220–1230. https://doi.org/10.29303/jipp.v9i2.2141

Wawan, & Retnawati, H. (2022). Empirical Study of Factors Affecting the Students' Mathematics Learning Achievement. *International Journal of Instruction*, *15*(2), 417–434. https://doi.org/10.29333/iji.2022.15223a

Widjaja, J. A., Jefferson, L., Ferdinand, M., Siahaan, B., Chow, A., & Widjaja, J. A. (2024). Utilizing Game Development Life Cycle Method to Develop an Educational Game for Basic Mathematics Using Unity 2D Game Engine. *International Journal of Computer Science and Information Technology (IJISIT)*, *1*(1), 20–30. https://doi.org/10.55123/ijisit

Wiwin, D. (2021). The Effectiveness of Online Learning Assisted by Google Classroom on Students' Learning Outcomes about Energy. *International Journal of Learning and Instruction (IJLI)*, *3*(2), 56. https://doi.org/10.26418/ijli.v3i2.50646