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The Effectiveness and Validity of Differentiated Mathematical Learning Media Based on the Smart App Creator Application in Developing Students' Thinking Creativity

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ABSTRACT
Challenges in mathematics learning, particularly in geometry transformation topics, continue to hinder the development of students' mathematical creative thinking skills. The urgency of this issue requires innovative learning media that not only support conceptual understanding but also accommodate diverse learning needs. This study aims to develop, validate, and test the practicality and effectiveness of GeoPlayMath, a differentiated mobile learning application designed to enhance students' mathematical creative thinking skills. Employing Research and Development (R&D) with the ADDIE model, the research involved grade IX-B students at SMP Negeri 2 Maleber. Data were obtained through expert validation, practicality questionnaires (students and teacher), and pre-test/post-test assessments. Results indicated that GeoPlayMath is valid and feasible, with expert validation scores of 85.12% (material; valid) and 97% (media; very valid). The practicality scores were 77% (students; practical) and 97% (teacher; very practical). Effectiveness tests demonstrated increased mean scores from 62.89 (pre-test) to 85.28 (post-test) with an N-Gain of 0.6 (moderate). The novelty of this research lies in integrating differentiated learning principles into mobile-based media developed using Smart App Creator. This study contributes a development framework for differentiated learning media that can guide teachers and future researchers.
Keywords: Differentiated Learning Media, Geometric Transformation, GeoPlayMath, Mathematical Creative Thinking Ability.

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Introduction

Education can help humans create new views on life and provide very important lessons about the world around them. Education can also help someone become more capable of dealing with problems that arise in a world that is increasingly technologically advanced and increasingly modern. Individuals who are more educated are usually better at Creative Thinking because they have gained knowledge about life in their learning process (Sutrisno, et al., 2023). According to Yu (2024), one of the functions of mathematics is to develop reasoning power. The development of this reasoning power can be obtained through investigation, experimentation and exploration. Besides that, it is also a tool for solving problems through mindsets and mathematical models, as well as a communication tool through symbols, tables, graphs, diagrams, in explaining ideas. Meanwhile, the purpose of mathematics learning is to train and develop scientific, systematic, logical, critical, creative,

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consistent ways of thinking, as well as develop tenacious attitudes and have strong confidence in facing and solving problems.

Creative thinking is something that students need to solve problems and find alternative solutions to the problems (Adiastuty, et al. 2020). National and one of the main objectives of the instructor is to educate students who have creativity (Sujana, 2019). In addition, the purpose of education in the Independent Curriculum is to improve the quality of learning, shape the character of independent students, and prepare students to be able to become innovative individuals. According to Torance (1981), creative thinking is the ability to generate new, original, and relevant ideas in solving problems or creating something new. He emphasized that creativity is not only about the ability to generate unique ideas, but also about the ability to develop those ideas into something meaningful.

Therefore, the potential for creative thinking is one of the significant qualities that students need to have (Zubaidah, 2017). The ability to think creatively mathematically is one of the high-level thinking skills or commonly called Higher Thinking Other Skills (HOTS). Students need to have this ability because with this ability students can be helped in finding solutions to their own problems. With this ability, students can also expand their imagination in finding various ideas in solving a mathematical problem or problems related to everyday life (Sutrimo, et al. 2019).

Deswita, et al. (2023), this condition requires countries in the world to have creative individuals, one of which is Indonesia. Indonesia as a developing country needs creative people who can contribute to the development of science and technology. According to Noprizal, et al. (2023), teachers who implement differentiated learning must act as highly competent facilitators, require high dedication, and hard work. In mathematics learning, the author not only measures mathematical problem-solving abilities but also student responses during the learning process are also things that need to be considered. Creative thinking is a person's skill in analyzing new information, and combining unique ideas or concepts to solve a problem. Creative thinking skills can be seen from the expertise in analyzing data, and providing varied problem-solving responses (Qomariyah & Subekti, 2021). Along with the development of the curriculum in the independent learning curriculum development program that is being initiated by the government of the Ministry of Education and Culture, it is a step towards realizing the profile of Pancasila students as a step towards realizing superior Indonesian human resources by implementing diverse intracurricular learning, namely prioritizing learning content to deepen and understand concepts and strengthen competencies (Syarifudin & Nurmi, 2022). Students need to get learning facilities, including teaching materials that can foster the ability to think critically,

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creatively, communicate, and work together effectively (Barus, 2024; Thornhill-miller et al., 2025).

In fact, every individual is different from one another. There are so many needs of students that must be met. Without realizing it, teachers face students with a variety of diverse types every day. Many teachers are not aware of this extraordinary skill, because it happens so naturally in the classroom and teachers face these challenges as a common thing for them. Seeing the many differences between one student and another, differentiated learning is needed (Khoiriyah, et al. 2024). According to Sutinah & Ristiana (2023) differentiated learning is a systematic approach to planning curriculum and teaching for diverse learners. At the implementation level, differentiated learning refers to the practice of implementing various instructional and learning adaptations to meet all the learning needs of diverse learners in the classroom, so that they can construct knowledge in their own way. There are three different approaches to differentiated learning, namely content, process, and product. 1) Content Differentiation is about the content that students learn related to the curriculum and learning materials. 2) Process Differentiation is how students process ideas and information, including how students choose a style to learn. 3) Product Differentiation, namely students demonstrate what they have learned (Febriana et al., 2023).

Based on previous relevant research, there are several differences in research results. This research is based on a review of previous studies that focus on learning media and mathematical creativity. A study by Sudiantini and Shinta (2018) shows that there is a significant influence of learning media on students' creative thinking and mathematical reasoning skills. However, this study does not specifically address the development of differentiated media. The study of Salsabila, et al. (2024) has indeed succeeded in developing Android-based mathematics learning media in the context of *Differentiated Learning* and stated that the product is valid, practical, and effective. However, the study did not specifically use the Smart App Creator app and did not highlight the results of increasing thinking creativity.

Furthermore, Purwanto and Gita (2023) developed an Android Game-based mathematics learning media that was stated to be interesting and very effective. The focus of this research is on Game-based media, which is different from the focus of this research which is a general differentiated media packaged through *Smart App Creator*. Meanwhile, contrasting findings were shown by Tsalitsah and Baalwi (2024), who concluded that Tangram media did not affect students' mathematical creative thinking

skills and only about 54.8% of students achieved the Minimum Completeness Criteria (MCC).

Based on this review, there is a research gap in the form of the need to develop mathematics learning media that is not only Android-based, but explicitly: 1) applying differentiated learning principles, 2) implementing using specific development tools (*Smart App Creator*), and 3) proven to be comprehensively effective (valid, practical, and effective) in develop students' creativity in thinking. Therefore, this research is here to bridge this gap by developing and testing differentiated learning media based on *Smart App Creator*.

Methods

Research Methods

The research used by the researcher is research and development. R&D is one of the research methods used to develop a product, then the product will be validated to determine the feasibility of the product. According to Sugiyono (2020), this research is a research that has results, namely the existence of a product, which can then be tested for feasibility for use. The results of the product developed from this research are Differentiated Learning Media with Smart Apps Creator Based on the ADDIE Approach for Junior High School Students.

Development procedures

This development procedure adopts the ADDIE development model. This teaching material development model uses the ADDIE model where ADDIE is often used because the stages of the ADDIE model describe a systematic approach to instructional development (Martatiyana et al., 2023). The ADDIE instructional model is an instructional process consisting of five phases, namely analysis, design, development, implementation and dynamic evaluation (Cahyadi, 2019). The product development procedure/stages are illustrated below (Figure 1).

According to Gagne et al. In Mulyasari et al. (2023) expanded the ADDIE Steps into more detailed procedural instructions as follows:

1. Analysis
   Analysis The main activities carried out at this stage are analyzing the background or need for the development of learning media and analyzing the feasibility and requirements for the development of learning media. The initial stage is to conduct a needs analysis to explore and find out the problems and solutions needed and appropriately with material analysis and competency analysis.
   a. Material analysis

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This material analysis is adjusted to the needs of students who support the creative thinking process based on observation results.

b. Competency Analysis
This competency analysis is a stage of analyzing the suitability of the competencies to be achieved.

c. Student Characteristics Analysis
Studying student profiles (learning styles, ability levels, access to technology) as the basis for designing differentiated learning.

d. Media/Technology Analysis
Determine the use of the Smart App Creator application as *a tool* for the development of Android-based interactive media.

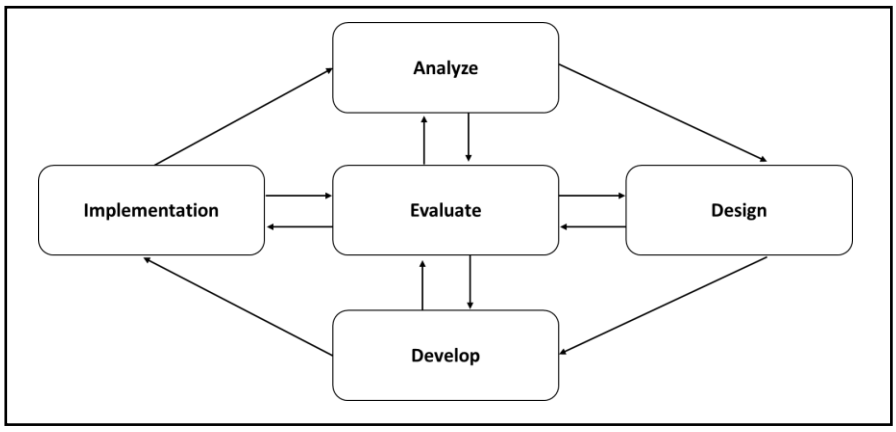

Figure 1. ADDIE Model Development Stages

2. Design Stage
This stage is the design stage of learning media. This activity is a systematic stage that starts from determining the objectives of learning media, designing materials or teaching and learning activities, and evaluation of learning. After conducting a needs analysis in the previous analysis stage, namely conducting the design stage including:

a. Media design creation
Media creation begins with making a storyboard or design sketch with the aim of clarifying the flow of the media (storyboard).

b. Gathering the Necessary Components
Collecting the required components and elements that will be included in the developed learning media.

c. Differentiated Learning Design
Design variations of content or activities in the media to accommodate differences in students' levels of understanding (content/process differentiation).

d. Instrument Design
   Prepare research instruments, such as validation sheets (for subject matter and media experts), student response questionnaires (practicality), and thinking creativity tests (effectiveness).

3. Development Stage
   a. Making Learning Media
      The developed media is made using Smart Apps Creator. Almost all components or elements are made in the software. The stages in making the media are making the interface or called design, managing slides, converting it into a software-assisted application, then testing it with installation on Android and operating it and then publishing it.
   b. Validation of Learning Media
      The developed media will be validated by four expert examiners, namely one media expert examiner and three material expert examiners. The expected results are in the form of comments and suggestions as well as input that will be used to improve the developed media.
   c. Product Revision
      Improve and improve the media based on input and suggestions from validators until they reach valid criteria (suitable for use).

4. Implementation Stage
   The testing of the developed learning media will be tested on students of grade IX B of SMP Negeri 2 Maleber accompanied by filling out a questionnaire for the assessment of the developed learning media. In the implementation stage, 6 meetings were held in three weeks. Reason At this age, students' abstract and logical thinking skills have developed better, so the application of innovative learning media such as those based on Smart App Creator will be more optimal in measuring the impact on thinking creativity. Grade 9 B can be representative of a population of students with diverse learning profiles who are in dire need of a differentiated approach (customization of content, processes, products) to ensure all students, regardless of their ability level, can develop their thinking creativity.

5. Evaluation Stage
   At this stage, the researcher reviews the learning media development process based on input and suggestions during the media validation process.

Result and Discussions

The results of the increase in students' mathematical creative thinking skills are seen from the results of the pre-test and post-test. This is certainly important to do because

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it is to find out whether there is an increase in students' creative thinking skills before and after using differentiated learning media. Based on the results of the pre-test and post-test conducted on February 1, 2025 and February 15, 2025, here are the results of the pre-test and post-test.

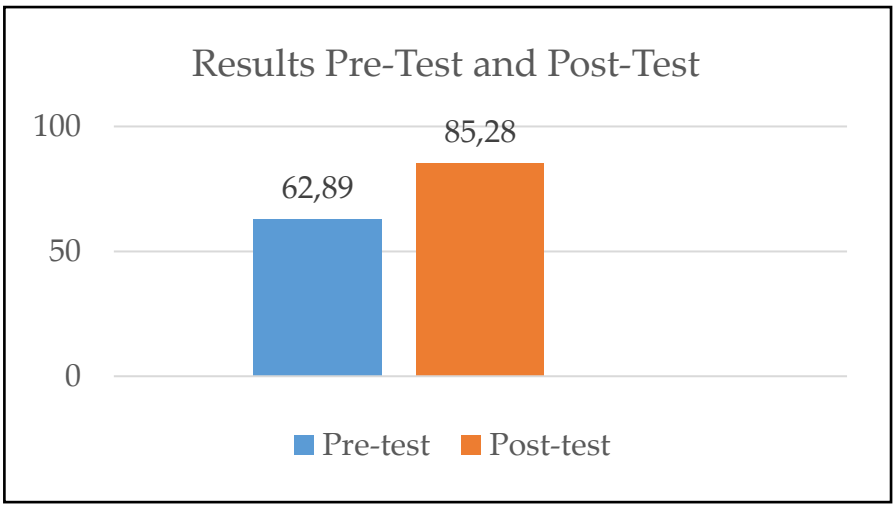

Figure 2. Average results of Pre-test and Post-test

Based on Figure 2, the pre-test results got an average score of 62.89 and the post-test results got an average score of 85.28. The results of data analysis to determine the N-Gain Score value got a result of 0.6. Based on the N-Gain criteria at an interval of 0.3-0.7, it is in the "Moderate" category. So it can be concluded that GPM learning media can improve students' mathematical creative thinking skills in the "moderate" category. Based on the results of the N-Gain calculation, it can be concluded that out of 31 students, 2 students have a low level of improvement, 20 students have a medium level of improvement, and 9 students have a high level of improvement.

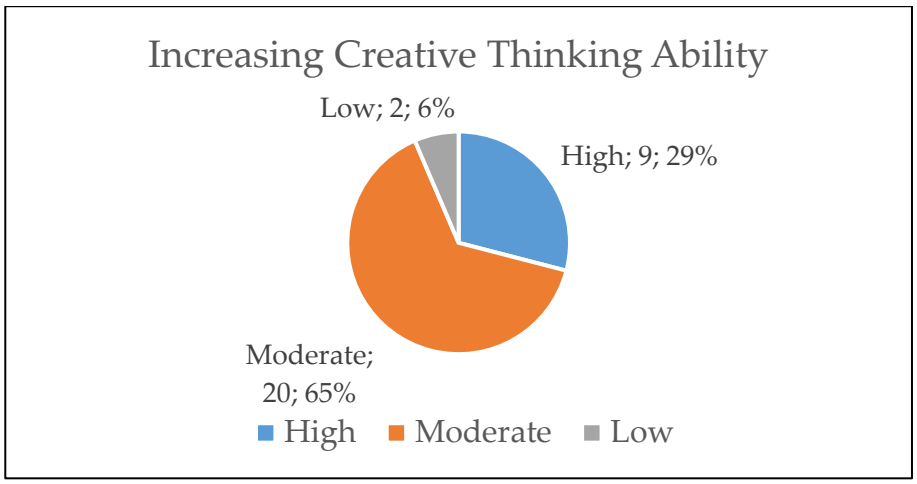

Figure 3. Improving Students' Creative Thinking Skills

Based on Figure 3, the increase in creative thinking skills of class IX B students of SMPN 2 Maleber, which are categorized into three levels: low, medium, and high. Presented in the form of percentages and the number of students in each category. Most (65%) of students are at a medium level of creative thinking skills. This shows that class IX B students of SMPN 2 Maleber generally have quite good creative thinking skills, but still have room for improvement.

In line with research conducted by Astria & Kusuma (2023), Differentiated learning is carried out by choosing the right strategy by considering student needs, the learning process and the work results to be assessed. By paying attention to various indicators of creative thinking skills and the application of a differentiated learning process, the goals of a teacher will be achieved. The results studied provide information that the application of differentiated learning can increase or improve students' mathematical creative thinking skills. To strengthen the evidence from the results of these analyses, the researcher provides an example of a student's answer that shows an increase in creative thinking skills, which can be seen as follows:

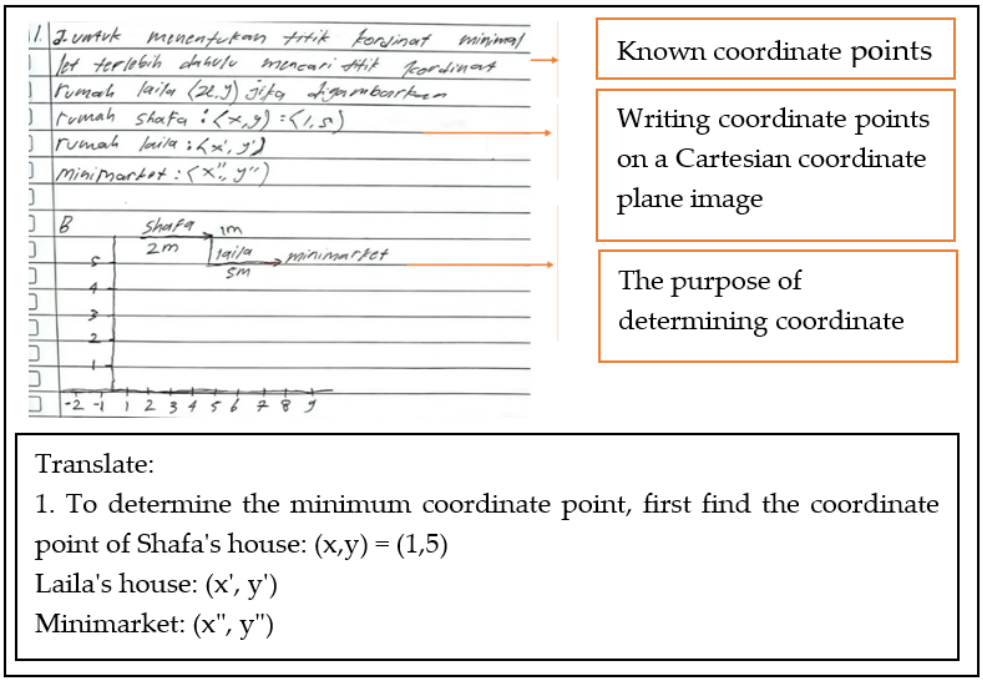

Figure 4. Fluency Aspect Pre-test Results

Fluency Aspect

From Figure 4 Pre-test Results of the Fluency Aspect, during the pre-test the student was able to work on questions with the fluency aspect but gave an answer that was not relevant to solving the problem. The ability to think creatively in mathematics at a moderate level on the fluency indicator, students were less able to work on the

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questions fluently, due to a lack of understanding of the previous material, (Pratiwi, Ajeng, & Dwijanto, 2019). The following are the results of the pre-test of the fluency aspect of Nova Azhari (AZ) students.

After being given geometric transformation learning for 4 meetings and given answers from the post-test results. The results were obtained in the following Figure 5.

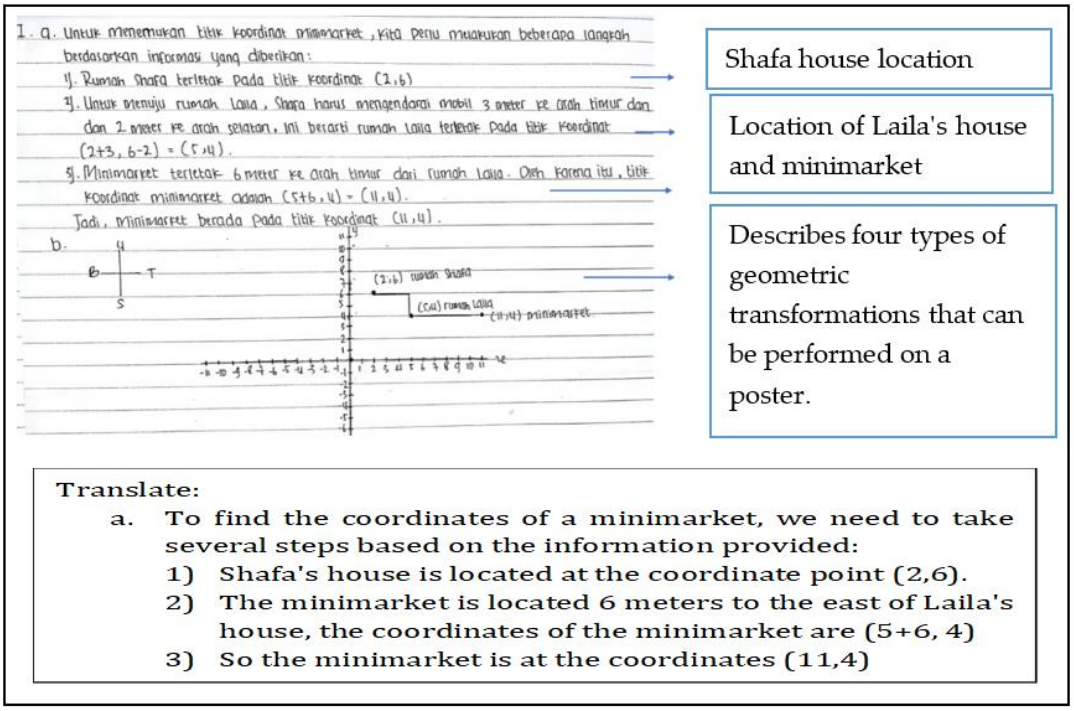

Figure 5. Fluency Aspect Post-test Results

From Figure 5 Post-test Results of Fluency Aspect, the AZ students have been able to complete the fluency aspect questions and overall they are correct because the AZ students provide many relevant ideas or concepts and the solutions are correct and clear. This can be said that there is an increase in creative thinking skills in the Fluency aspect.

Flxibility Aspect

Figure 6 are the pre-test results for the Flexibility aspect of AZ students. From Figure 6 Pre-test Results of Flexibility Aspect, during the pre-test the student was able to work on questions with the flexibility aspect only providing ideas in only one way but providing the correct answer. After being given learning about geometric transformation and given answers from the post-test results, the results are obtained in Figure 7.

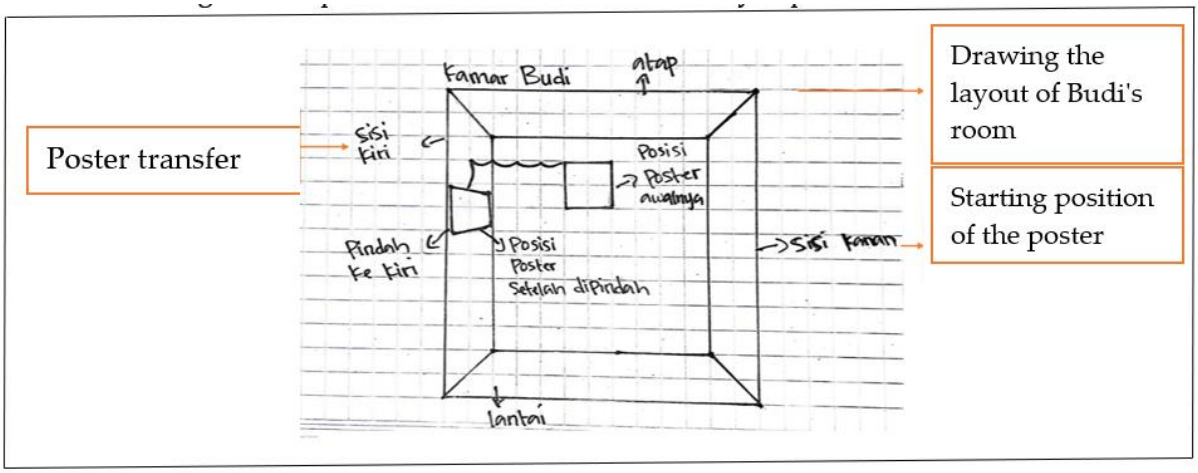

Figure 6. Flexibility Aspect Pre-test Results

Aspect, student AZ has been able to complete the Flexibility aspect questions and overall it is correct because student AZ provides more than one way (various) and different alternative solutions and the results are correct. This can be said that there is an increase in creative thinking ability in the flexibility aspect (Figure 7).

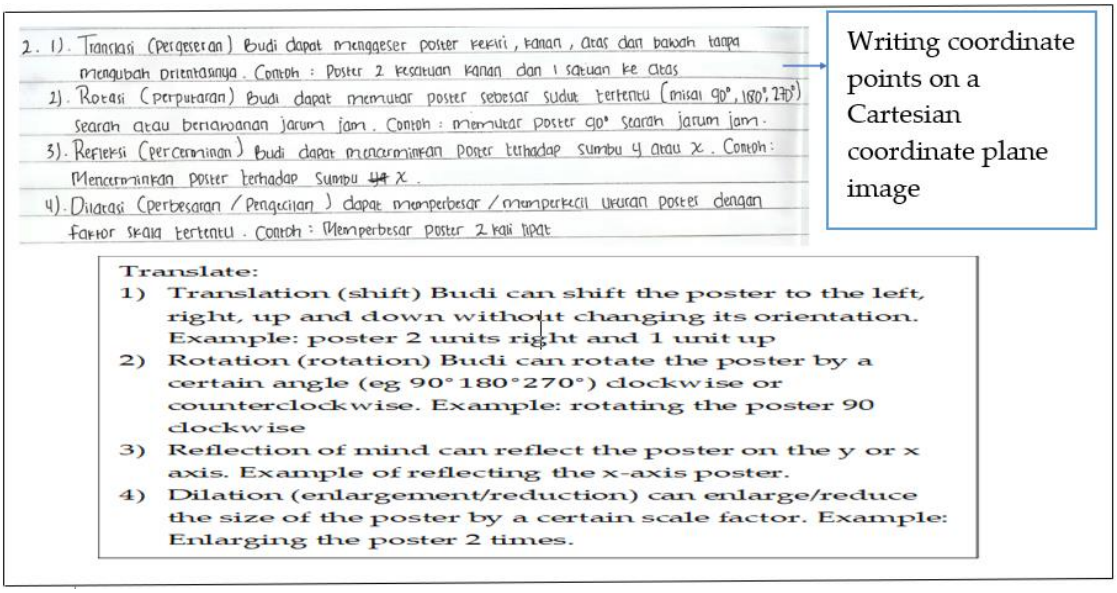

Figure 7. Flexibility Aspect Post-test Results

Originiality Aspect

The originality aspect is an aspect that provides answers using new strategies. The following are the results of the pre-test of the originality aspect of student AZ.

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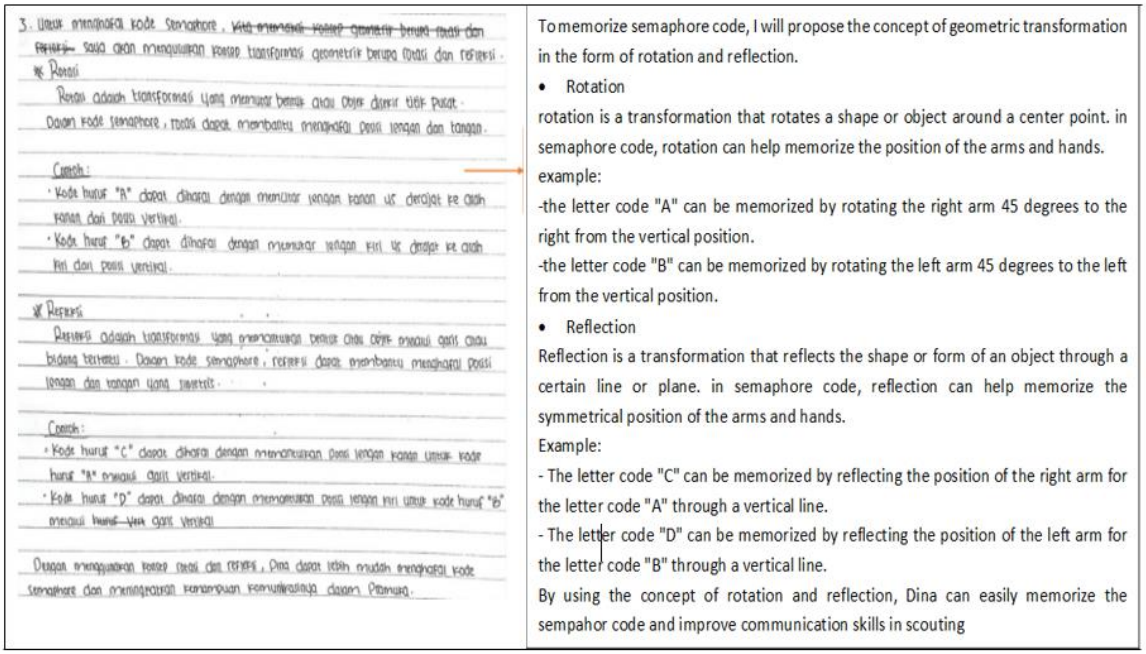


To memorize semaphore code, I will propose the concept of geometric transformation in the form of rotation and reflection.

- Rotation

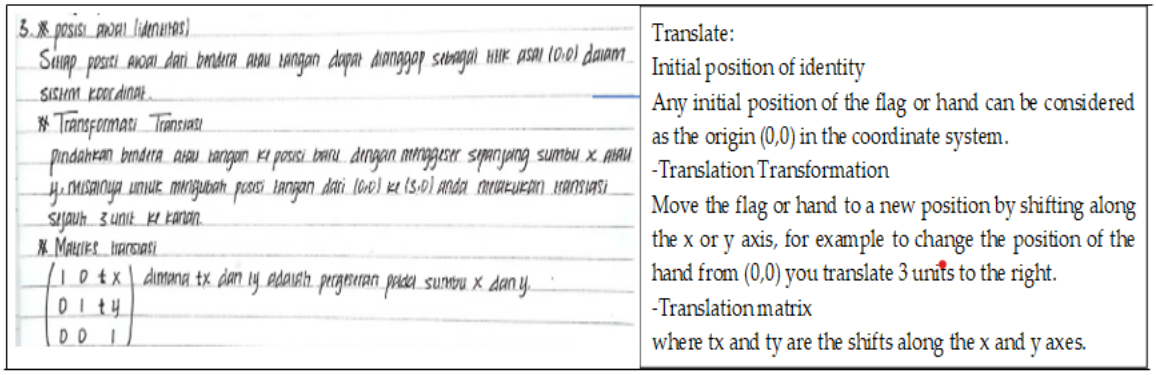
rotation is a transformation that rotates a shape or object around a center point. in semaphore code, rotation can help memorize the position of the arms and hands.
example:
-the letter code "A" can be memorized by rotating the right arm 45 degrees to the right from the vertical position.
-the letter code "B" can be memorized by rotating the left arm 45 degrees to the left from the vertical position.

- Reflection

Reflection is a transformation that reflects the shape or form of an object through a certain line or plane. in semaphore code, reflection can help memorize the symmetrical position of the arms and hands.
Example:
- The letter code "C" can be memorized by reflecting the position of the right arm for the letter code "A" through a vertical line.
- The letter code "D" can be memorized by reflecting the position of the left arm for the letter code "B" through a vertical line.
By using the concept of rotation and reflection, Dina can easily memorize the sempahor code and improve communication skills in scouting

Figure 8. Originality Aspect Pre-test Results

From Figure 8 Pre-test Results of the Originality Aspect, that student AZ provided a common solution, so it can be concluded that student AZ was able to answer question no. 3 but had not produced unique ideas. After being given learning about geometric transformation and given answers from the post-test results, the results were obtained in the following Figure 9.



Translate:
Initial position of identity
Any initial position of the flag or hand can be considered as the origin (0,0) in the coordinate system.
-Translation Transformation
Move the flag or hand to a new position by shifting along the x or y axis, for example to change the position of the hand from (0,0) you translate 3 units to the right.
-Translation matrix
where tx and ty are the shifts along the x and y axes.

Figure 9. Originality Aspect Post-test Results

From Figure 9 Post-test Results of the Originality Aspect, student AZ has been able to solve the originality aspect questions because he found different solutions and produced unique ideas. This can be said to have increased creative thinking skills in the originality aspect.

Elaborations Aspect

The elaboration aspect is an aspect that looks at students' answers that can explain in detail, sequentially to mathematical procedures. The following are the results of the pre-test of the elaboration aspect of student AZ.

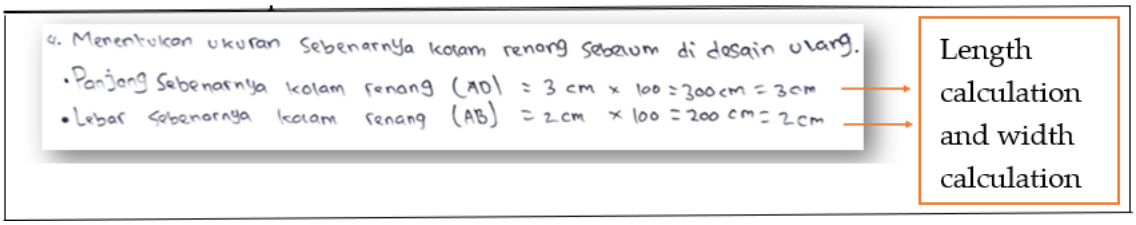


Figure 10. Elaboration Aspect Pre-test Results

From Figure 10, the results of the pre-test on the elaboration aspect, student AZ's answer needs to be supplemented with an explanation of the concept behind it, clarity of units, and a little context about the actual measurement results, so it can be concluded that student AZ was unable to work on question no. 4, which is about the elaboration aspect in the pre-test. After being given transformation learning and given answers from the post-test results, the results are obtained in the following figure 11.

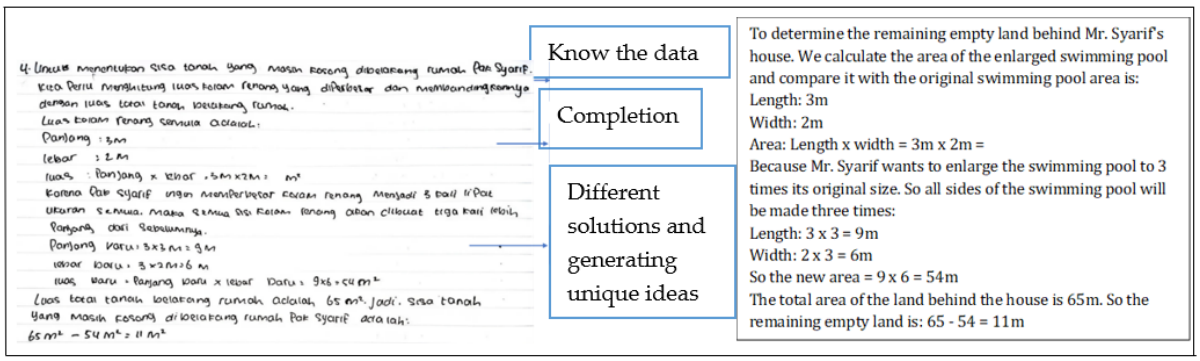


Figure 11. Elaboration Aspect Post-test Results

From Figure 11 Post-test Results of Elaboration Aspect, student AZ has been able to complete the elaboration aspect questions and overall it is correct because student AZ gave correct and detailed answers. This can be said that there is an increase in creative thinking ability in the elaboration aspect.

The findings of this study are in line with the results of the studies of Salsabila, et al. (2024) and Purwanto and Gita (2023), which also stated that the developed Android-based learning media (both differentiation media and educational *games*) was declared valid and practical to use. This reinforces the evidence that the adoption of

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mobile technology is a *feasible* option and is easy to implement in mathematics learning in schools. After conducting the trial of the learning device, the next step was to see the improvement in the aspect of students' mathematical thinking skills using pre-test and post-test questions.

The overall results showed that the average N-Gain was included in the "moderate" category. After conducting the trial of the learning device, the next step was to see the improvement in the aspect of students' mathematical thinking skills using pre-test and post-test questions. The overall results showed that the average N-Gain was included in the "moderate" category.

Conclusion

This study concludes that the SAC-based differentiated mathematics learning media, GeoPlayMath, is valid, practical, and effective for improving students' mathematical creative thinking skills in geometry transformation learning. Validation results from material experts and media/design experts demonstrate that the media meets high-quality standards in terms of content accuracy, visual-interactive design, usability, and its ability to support differentiated learning needs, placing it within the valid to very valid categories. Practicality assessments by students and teachers further confirm that the media is feasible and easy to use, categorized as practical and very practical respectively. Effectiveness testing through pre-test and post-test analysis revealed significant improvement in mathematical creative thinking skills, with an N-Gain score categorized as moderate. These findings directly answer the research question, demonstrating that GeoPlayMath meaningfully enhances students' creative thinking in mathematics. The Smart App Creator platform plays a crucial role in enabling interactive, mobile-based, and personalized learning experiences that increase student engagement and motivation. Overall, this research provides empirical evidence that differentiated learning media developed through the ADDIE model can serve as a powerful alternative learning resource, supporting innovation in mathematics education and offering a replicable framework for future development and research.

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Author's Declaration

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Conflict of Interest	:	This publication strengthens my CV for scholarships, further studies, or job opportunities, and helps me graduate with high marks.

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