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Development of Mathematics Learning Tools Using Hopscotch Games to Enhance Students' Creative Thinking in the Topic of Plane Figures' Area

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ABSTRACT: The creative thinking ability of students in mathematics remains very low in practice. Creative thinking skills can be enhanced through contextual mathematics learning by connecting mathematics to everyday life, and one of its examples is the use of hopscotch games. However, in reality, there are no existing learning tools that incorporate games to improve students' creative thinking skills. This study is a developmental research aimed at designing mathematics learning tools with hopscotch games on the topic of the area of plane figures, aligned with the Merdeka Curriculum. The development model used is the 4D model. Data collection techniques include observation, tests, and questionnaires. Validity is determined through the validation results of teaching modules, student worksheets and test packages. Practicality is assessed from observations on the implementation of the learning tools, while effectiveness is measured by learning mastery, N-Gain category, student response questionnaires, and statistical tests. The research results indicate that the developed learning tools meet the criteria of being valid, practical, and effective. The validity coefficients for the teaching module, student worksheets and test packages are 3.38, 3.31, and 3.43. The observation results for the implementation of the learning tools achieved a score of 3.83, categorized as high. The classical mastery percentage reached 76.5%, with 100% of students in at least the medium N-Gain category. Students' responses were positive, and there was a significant influence of the implementation of mathematics learning tools with hopscotch games on improving students' creative thinking skills. Therefore, these learning tools are deemed feasible and effective for enhancing students' creative thinking abilities through hopscotch games.

KEYWORDS: Creative thinking, Hopscotch game, Plane figures.

INTRODUCTION

Mathematics plays a crucial role in life. It needs to be taught from the elementary school level to develop systematic, logical, creative, disciplined, and collaborative thinking skills. Therefore, enhancing creative thinking is one of the benefits of learning mathematics (Handoko, 2017; Siregar *et al.*, 2020). Creative thinking is the ability to analyze something based on available data while also generating new and more refined concepts and determining various alternatives with ideas that can be used to solve problems (Firdaus *et al.*, 2021; Siregar *et al.*,2020). Creative thinking is one of the essential skills individuals must possess in the 21st century (Nurjan, 2018; Saidah *et al.*, 2020). The Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia designed the Merdeka Curriculum to strengthen the Pancasila Student Profile, and one of those dimensions is creativity. Mathematical creative thinking ability refers to the capacity to solve problems easily, simply, and flexibly in relation to mathematics (Situmorang, 2022). The aspects of creative thinking include: (1) fluency, the ability to generate many ideas; (2) flexibility, the ability to produce varied ideas; (3) originality, the ability to create new ideas or ideas that did not exist before; and (4) elaboration, the ability to develop or expand ideas to produce detailed or refined concepts (Dewi, 2018; Siregar *et al*., 2020; Ulfa *et al.*, 2018).

Previous studies conducted by Dewi (2018) and Laila (2021) revealed that students' creative thinking ability in mathematics is still very low. This occurs because creative thinking processes are rarely facilitated by teachers; students typically solve problems only based on the examples provided by the teacher (Ardiansyah *et al.*,2023). Similarly, Andiyana *et al.*, (2018) stated that students' creative thinking ability cannot develop if teachers do not actively involve students in constructing concepts during learning activities. Additionally, the teaching methods employed are still predominantly teacher-centered. Therefore, developmental research is needed to enhance creative thinking skills, as these abilities must be practiced and cultivated in classroom learning activities by implementing appropriate learning models or approaches (Mashitoh *et al.*, 2019).

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Creative thinking skills can be enhanced through contextual mathematics learning by relating mathematics to everyday life (Hermawan *et al.*, 2019). One way to introduce mathematical concepts in daily life while providing students with enjoyment is through games. However, the reality at schools shows that most teachers have not been able to integrate mathematics lessons with local culture (Suwito & Trapsilasiwi, 2016). Dienes' theory focuses on teaching mathematics to children in ways that capture their interest and make learning mathematics engaging (Sari & Tertemiz, 2017). According to Dienes (as cited in Ruseffendi, 1992), mathematical concepts are effectively learned through five stages: (1) free play, (2) rule-based games, (3) games of common attributes, (4) representational games, (5) symbolic games, and (6) formalization. One traditional game that can be incorporated into mathematics learning is the hopscotch game (Ardiansyah *et al.*,2023). According to Yanti *et al.*, (2022) in Javanese, hopscotch means hopping on one foot. This traditional game involves creating patterns on the ground in the form of plane figures, then playing by hopping on one foot and tossing a marker *gaco* onto one of the patterns.

Through the *hopscotch* game, students can preserve traditional games, as these have recently lost popularity among students. Many of them do not know the types of traditional games or how to play them (Nur'Aeni *et al.*, 2020). This game also serves as a tool to divert students from the negative impacts of smartphones. Hopscotch is a form of local culture that can be used as an alternative medium for ethnomathematics-based learning, particularly in geometry topics (Aprilia *et al.*, 2019). Ethnomathematics involves teaching mathematics conceptually through local cultural themes, including practices familiar to students or the surrounding community (Yudianto *et al.*, 2021). The geometric patterns in the hopscotch game, such as squares, triangles, rectangles, and circles, can be used as instructional tools in teaching the topic of area of plane figures. Related studies conducted by Herianto *et al., (2021)* and Nasobandi (2022) found positive effects of the ethnomathematics approach on students' creative thinking abilities. Similarly, research by Suryaningsih & Munahefi (2021) on the application of ethnomathematics-based puzzles through the hopscotch game in the topic of plane figures demonstrated positive results and responses from students. These findings indicate that ethnomathematics-based learning through games is effective when applied in the learning process.

The reality is that many students experience difficulties in understanding geometric concepts, particularly in the topic of plane figures. This is supported by research from Fauzi & Arisetyawan (2020) which found that one of the challenges faced by students is in the use of concepts, such as their inability to articulate the meaning of terms representing plane figure concepts and their difficulty in recalling the necessary conditions for an object to be defined in terms of perimeter and area. A contributing factor to this problem is the conventional teaching model implemented at schools. Teachers dominate the classroom with lecture methods and only provide exercises for students to complete. This approach is monotonous and makes students passive learners. Therefore, it needs to be replaced or varied with more meaningful processes, such as Outdoor Learning in Mathematics.

To address this issue, Outdoor Learning methods combined with the hopscotch game can be applied in mathematics lessons, particularly in teaching the area of square plane figures. This can assist teachers in achieving the desired learning objectives (Pambudi, 2022). Based on observations and interviews with mathematics teachers at SD Negeri Canggu, it was found that the quality of mathematics instruction in elementary schools does not yet meet expectations or the objectives of mathematics education. Mathematics learning outcomes remain low, and there are no Merdeka Curriculum-based learning tools to support the improvement of students' creative thinking skills. Thus, it is necessary to develop learning tools aimed at enhancing students' creative thinking skills in geometry, specifically in the area of plane figures. Based on this background, the research entitled **"Development of Mathematics Learning Tools Using the Hopscotch Game to Enhance Students' Creative Thinking in the Topic of Plane Figures' Area"** is proposed.

RESEARCH METHODS

This research is a development study aimed at producing a new product or improving an existing one. The development research uses the 4D development model, which consists of four stages: defining, designing, developing, and disseminating. The development research conducted focuses on developing a mathematics learning model with the hopscotch game, which includes a teaching module, Student Worksheets and a test package to assess creative thinking abilities in the topic of the area of plane figures.

The research was conducted at SDN Canggu, located in the Jetis District of Mojokerto Regency, with the research population involving the fourth-grade students. The reason for selecting this research location is the willingness of SDN Canggu to be used as a research site, and because the school is currently implementing the Merdeka Belajar Curriculum. One of the dimensions of this curriculum is creative thinking. Therefore, the school is open to new approaches, especially those related to enhancing creative

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thinking. Additionally, SDN Canggu has not yet implemented a learning model or learning tools incorporating the hopscotch game. Data collection techniques include observation, tests, and questionnaires. The research data analysis is explained as follows: 1) Validity analysis. The validity level is categorized into several types served in Table 1. The instruments fulfill the validity criteria if at least reaching the valid category.

Table 1. Interval of Validity

Interval	Category
$1 \le V_a < 2$	Invalid
$2 \le V_a < 3$	Enough Valid
$3 \le V_a < 4$	Valid
$V_a = 4$	Very Valid

2) Practical analysis of learning tools illustrates the implementation of these tools. This data is obtained from the results of the implementation observation, which are recorded on the observation sheet for the implementation of the learning tools. The learning tools in this study are considered practical if the analysis of the implementation observation yields a conclusion of at least a high level, with only minor revisions. If the implementation of the learning tools results in an implementation outcome (IO) below high, revisions need to be made based on the feedback from the observer, followed by trials. These trials can be conducted multiple times until the ideal learning tools are achieved with an IO score of at least high. The practical level is categorized into several types served in Table 2.

Table 2. Interval of Practically

Score	Conclusion
$1 \le IO < 2$	Low
$2 \le IO < 3$	Medium
$3 \le IO < 4$	High
$IO = 4$	Very high

3) Effectiveness analysis of learning tools. The assessment of the effectiveness of a learning tool refers to several criteria. These include learning completeness, N-gain category, student responses, and statistical tests in the experimental and control classes. The learning tools are categorized as effective if the learning outcomes show at least ≥70% of the total number of students achieving classical completeness with a Minimum Passing Criterion of 65, the number of students in the creative thinking N-Gain category with at least a medium level should be ≥70% of the total number of students, and the number of students who give positive responses, indicated by "Yes" answers on each aspect, should be ≥80%. Last, the results of the statistical test show that there is a significant effect from the implementation of the mathematics learning tools with the hopscotch game on the improvement of students' creativity.

The statistical test aims to analyze data from the experimental and control classes with t-Test. Statistically, the research hypothesis can be formulated as follows:

H_0 = There is no significant difference in the average from the implementation of mathematics learning tools with the hopscotch game on the improvement of students' creativity.

H_1 = There is a significant difference in the average from the implementation of mathematics learning tools with the hopscotch game on the improvement of students' creativity.

RESULT AND DISCUSSION

This section describes the development of a mathematics learning tool with the hopscotch game to enhance students' creative thinking skills using the 4D development model, which includes several stages: defining, designing, developing, and disseminating.

First, the defining stage. The defining stage is the initial stage that involves analysis activities. The goal of this phase is to identify and define the needs of the learning process by examining the objectives and limitations of the material. This phase consists

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of five key stages: 1) front-end analysis; 2) analysis of learners; 3) concept analysis; 4) task analysis; and 5) specifying instructional objectives. At SDN Canggu, the learning media used are mathematics textbooks for students published by the Ministry of Education and Culture. The majority of teachers assign tasks in the form of routine problems from these textbooks and worksheets published by private publishers. Therefore, additional learning media is needed to help students engage in discussions and develop their creative thinking skills. One such tool is the student worksheet specifically designed to enhance students' creative thinking skills through the hopscotch game.

Second, the designing stage. In this stage, the learning tools are designed based on the needs determined in the defining phase, resulting in an initial design (draft 1) that will then be validated by experts and tested. The learning tools include the teaching module, student worksheets and a test package with the hopscotch game. This stage involves the preparation of tests, selection of media, format selection, and initial design. Test questions are created to measure creative thinking skills, consisting of four essay questions based on the indicators of creative thinking. The process starts with creating a test blueprint, including possible answers and scoring guidelines, to ensure the scores reflect students' creative thinking abilities. The media selection supports teaching materials, using Microsoft PowerPoint to help students actively engage, student worksheets to boost creative thinking, and YouTube to demonstrate how to play hopscotch.

Third, the developing stage. This activity aims to test the validity of draft 1 by obtaining feedback and suggestions regarding the learning tools and research instruments. The validation was conducted by three validators: one lecturer from Universitas Bakti Indonesia, one lecturer from Universitas Negeri Surabaya, and one teacher from SDN Canggu. The validation results and expert feedback were used as the basis to improve draft 1, which was then revised once and met the validity criteria, resulting in draft 2. Next, in this stage, the goal is to analyze the practicality and effectiveness of the learning tools. Based on the analysis of the validation data, the validity coefficient for the mathematics learning tools with the hopscotch game was obtained, as shown in Table 3.

Table 3. Coefficient of Validity

Learning Tools	Coefficient	Category
Teaching module	3,38	Valid
Student worksheet	3,31	Valid
Test packages	3,42	Valid

The teaching module, student worksheets, and test package, which have been validated, are then field-tested in class 4B as the trial class. In this learning activity, students participated in a pre-test and then played hopscotch, a traditional game, to explore area concepts. The first meeting involved some technical issues with the projector and some confusion as students were unfamiliar with the game and the topic of the area. However, they were excited to create *gaco* (game pieces) with various creative designs. In the following activities, students played hopscotch using their *gaco* to measure areas with non-standard units, like paper pieces. They encountered some broken gaco pieces, but the teacher replaced them with origami. The students actively discussed and calculated the areas of their plots. As they continued, they transitioned to using standard units of measurement, and the calculations showed consistent results. By the end of the lessons, students responded positively to the use of hopscotch in learning, and they filled out a questionnaire about the experience. The post-test results indicated that the learning method was engaging and effective in improving their understanding of the area.

Figure 1. The Results of Creativity in Gaco Creation

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An interesting observation during the lesson was that most students were very enthusiastic about playing hopscotch. This was evident after the second meeting when, before the third session was even explained, they had already asked, "Are we going to play again tomorrow, Teacher?" In the midst of the current situation, where traditional games are rarely encountered, students are excited and enjoy these games when taught to them. This is supported by Bawazir *et al.*, (2023) and Aziz & Susan (2021) state that playing hopscotch provides a new experience for students while also being a fun activity, giving players a sense of satisfaction. However, when the teacher instructed that the playtime had ended, the students still wanted to continue playing, showing expressions of dissatisfaction with the allotted time. Some even mentioned that they would borrow the game board during break time to play again.

Figure 2. Students Play Hopscotch Game

Then, a practicality analysis of the teaching device that had been tested was conducted by observing the implementation of the learning process. The results of the practicality test can be seen in Figure 3.

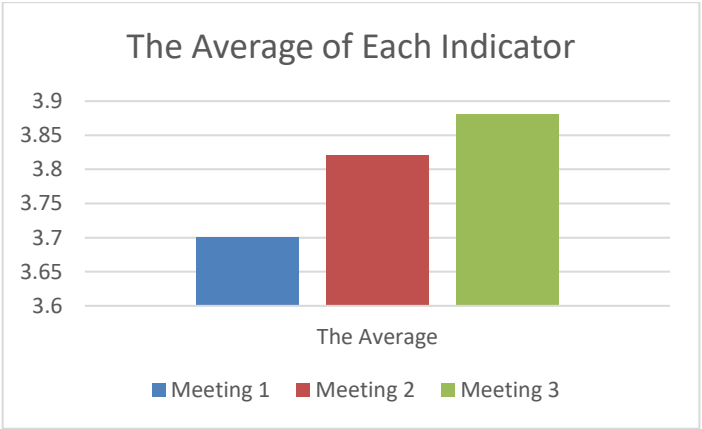

Figure 3. The Average of Each Indicator

Based on the image, it can be seen that the average implementation scores of the learning device for the first meeting to the final meeting were 3.7, 3.82, and 3.88, respectively. From the analysis of the data on the implementation of the learning device, the overall average for all aspects was 3.83, which falls within the range of $3 \leq IO < 4$, indicating a high level. This conclusion indicates that the learning device is considered practical.

Next, the effectiveness analysis was conducted through four indicators: learning completeness, N-gain category, student response, and statistical tests. The learning completeness achieved by students in the creative thinking ability test showed that 26

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out of 34 students scored above the Minimum Mastery Criteria, resulting in a classical completeness percentage of 76.5%. This percentage indicates that the students in the experimental class are classified as having achieved classical completeness. The second indicator is the improvement in N-Gain. It is known that the average N-Gain category is high, with 100% of students achieving a score ≥ 70%, placing them in the at least moderate category. This percentage concludes that the students in the experimental class meet the effectiveness criteria based on the N-Gain category. The highest N-Gain score obtained was 1.00, and the lowest was 0.38. Next, the student response. It is known that the student response percentage is 85.6% with a positive response. Therefore, the teaching device meets the effectiveness category based on student responses. Based on the three indicators, the teaching device can be considered effective. The final indicator is the statistical testing between the experimental and control classes. In the statistical t-test analysis, the significance result was 0.000, which is less than 0.05. This indicates that there is a significant effect of implementing the mathematics learning device with the hopscotch game on the students' creative thinking skills.

The hopscotch game-based learning tool is effective in encouraging students to be active and creative, especially during discussions and while solving worksheets. Students used their creativity when making *gaco* and explaining their choices. During measurements with non-standard units, they were required to think creatively. After playing hopscotch, students developed strategies to win the game. This supported by Rahmat & Nur (2024) stated that traditional games help develop intellectual and emotional intelligence, creativity, motor skills, and character.

Despite of less intensive practice in the experimental class, post-test results were better compared to the control class. The hands-on learning approach, including real-world measurement practice, improved students' understanding. This is consistent with studies by Arafah *et al.*, (2023); Erliansyah *et al.*, (2023); Yullah *et al.*, (2022) which found that the experimental class outperformed the control class due to the specific treatment. Statistical tests showed significant improvement in creative thinking skills in the experimental class, with an N-Gain of 0.68 (high) compared to 0.29 (low) in the control class.

Based on the discussion above, the findings of this study indicate that the math learning tool using the hopscotch game is effective in enhancing students' creative thinking abilities. The significant difference in impact from implementing this tool aligns with several studies, including Apriliana, (2023); Ardiansyah et al., (2023); Yuzila *et al.*, (2023) which show that learning models focused on outdoor learning and the hopscotch game can improve students' creative thinking skills. Overall, based on the analysis of validity, practicality, and effectiveness, it can be concluded that the math learning tool with the hopscotch game meets the criteria of being valid, practical, and effective.

The final stage is dissemination. This math learning tool is distributed offline at SDN Canggu and SDN Terusan 1, Gedeg District, Mojokerto Regency, as well as at the library of the Faculty of Teacher Training and Education, University of Jember. Online, this learning tool can be accessed through social media platforms such as Instagram, YouTube, and Facebook, with a Google Drive link provided for access to all the learning materials.

Based on the research activities conducted, there are several strengths and weaknesses, both in the research process and the implementation of the learning tool. The strengths of this math learning tool include that the teaching module is designed according to the latest curriculum, presenting a systematic learning approach for each session. The developed student worksheet makes students active and enhances their creativity, especially through the game hopscotch, which is aimed at teaching the area of flat shapes. Additionally, the learning tool is designed online using Canva, making it visually appealing and easy for students to understand. The weaknesses of this research include the limited distribution, as it was only spread across a few schools and online platforms. Moreover, the hopscotch game requires more time to implement because students need guidance on the game rules, followed by the gameplay itself, and preparation of the tools and materials. This approach may not be suitable for students who do not enjoy motor activities. Furthermore, the research was conducted in just one school within a limited time frame.

CONCLUSION

The research and development process from the initial analysis to the end has been carried out and concluded that the development of the mathematics learning module with the hopscotch game in the Merdeka Curriculum is considered valid, practical, and effective. Additionally, the students' creative thinking skills have improved. This research is expected to serve as a reference for more innovative learning processes in schools with the Merdeka Curriculum. The next recommendation for other researchers is to develop different learning materials for a broader research subject in various schools to enhance mathematical skills and others.

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