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Analysis of Student Needs in Interactive Multimedia-Based Mathematics Learning to Improve Problem-Solving Skills Using the Design Thinking Method

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Abstract. *The main problem in this study is that many students consider mathematics a difficult subject to learn, which results in a lack of student motivation and passive, less participatory mathematics learning between teachers and students. This study aims to explore solutions to problems that arise in mathematics learning through the design thinking method, as outlined by David Kelley, which consists of 5 stages: empathize, define, ideate, Prototype, and test. In this problem exploration, 3 stages are used: empathize, define, and ideate to generate solution ideas from several possible solutions. The study population comprised 25 eighth-grade students and 3 mathematics teachers at SMP Al Islam, Mts Fathul Huda, and SMPN 2 Sayung. Data were collected using a Google Form questionnaire. The results of the data obtained are then analyzed from the empathize to the define stage. The results of this study indicate that the problem-based learning model, supported by GeoGebra and Canva, can improve students' problem-solving abilities. Based on the results of this exploration, researchers developed interactive media using the design thinking method to improve problem-solving abilities.*

Keywords: *mathematics, interactive media, problem solving*

INTRODUCTION

In the current era of globalization, science and technology are advancing rapidly, keeping pace with the times. Along with the development of the Industrial Revolution 4.0, human work methods are shifting towards automation or digitalization. One of these is that quality education will create superior human resources who are useful in advancing a nation. One impact in the world of education is in school activities, where new information and knowledge spread rapidly and are easily accessible to anyone who needs them. One of the subjects needed to face the Industrial Revolution 4.0 era and improve mastery of science and technology is mathematics (Anggraeni et al., 2021).

Mathematics is a compulsory subject taught in every school. In mathematics learning, teachers should not only provide abstract symbols and expressions that bore most students. With clear learning objectives and a realistic approach,

mathematics becomes a daily companion for students (Andriono et al., 2021). Mathematics is a crucial subject in education because it helps develop logical, critical, systematic, and creative thinking skills. Furthermore, mathematics education aims to train students to solve everyday problems. Problem-solving skills are one of the key competencies students must possess in mathematics learning, as they can analyze situations, formulate solution strategies, and draw accurate conclusions.

However, in reality, students' mathematical problem-solving skills are still relatively low. This is evident in the difficulties they face in understanding problems, determining solution strategies, and interpreting the results. Furthermore, most students show little interest in mathematics learning. The conventional, teacher-centered approach to learning leaves students less actively involved in the learning process, leading to lower motivation and weaker higher-order thinking skills, particularly in problem-solving.

Learning is a series of activities deliberately designed to facilitate the learning process (Pribadi, 2009). Another definition of learning is put forward by Patricia L. Smith and Tillman J. Ragan (1993), who state that learning is the development and delivery of information and activities designed to facilitate the achievement of specific goals. Mathematics learning in elementary and secondary schools often faces complex challenges. Analyzing student needs in mathematics learning is crucial to help educators understand and create better learning experiences. This way, students can overcome difficulties and achieve optimal learning outcomes. The abstract nature of mathematical learning remains difficult, and many students even fear it (Marfu et al., 2022).

One way to improve problem-solving skills is to use interactive learning media. Research by Habuke et al. (2022) shows that interactive learning media using articulate storylines can improve problem-solving skills. Problem-solving is a crucial skill for students to face the challenges of the modern world. In the context of mathematics learning, contextual problem analysis helps students understand concepts in depth, identify evaluation criteria, and develop solutions. However, in reality, many students still struggle to develop problem-solving skills in

mathematics because learning tends to be conventional and less interactive. This situation demands innovative learning approaches that create more engaging and meaningful experiences and encourage students to participate in the problem-solving process actively. Therefore, an approach is needed to identify students' learning needs and design learning tailored to their characteristics and needs. One approach to analyzing student needs is Design Thinking.

With this approach, teachers can identify the problems students face in mathematics learning and design more relevant and effective learning strategies. To make learning more engaging and interactive, the Problem-Based Learning model can be supported by learning technologies such as GeoGebra and Canva. GeoGebra allows students to dynamically visualize mathematical concepts, facilitating their understanding of abstract concepts. At the same time, Canva can be used to present learning materials and media in more engaging and creative ways. This technology integration is expected to increase student interest in learning while supporting the problem-solving process.

Problem-solving is a person's ability and actions to identify, analyze, and resolve a problem or situation that presents a challenge. Problem-solving skills can be developed through the learning process and cannot be innate. Consequently, students tend to memorize formulas and struggle with complex problems. This indicates that students' problem-solving abilities are not yet optimal. This research, conducted by Hafizah & Samosir (2023), shows that interactive learning media based on the Canva application can improve 8th-grade students' mathematical problem-solving abilities.

In the explanation above, in this study the researcher will explore the design of interactive media in mathematics learning towards student problem solving using the design thinking method, where this method itself is described as a way of thinking or cognitive process manifested in the act of designing the thought process (Dunne & Martin, 2006) with five stages or phases of the Stanford School of Design Thinking (Bill Schmarzo, 2017) namely Empathize, Define, Ideate, Prototype and Test / Evaluate.

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RESEARCH METHOD

The research method used was design thinking. Design thinking is a creative approach to solving problems and finding innovative solutions. Design thinking has five stages: Empathize, Define, Ideate, Prototype, and Test.

The following are the stages or phases, according to David Kelley, Founder of IDEO and the Stanford School of Design Thinking:

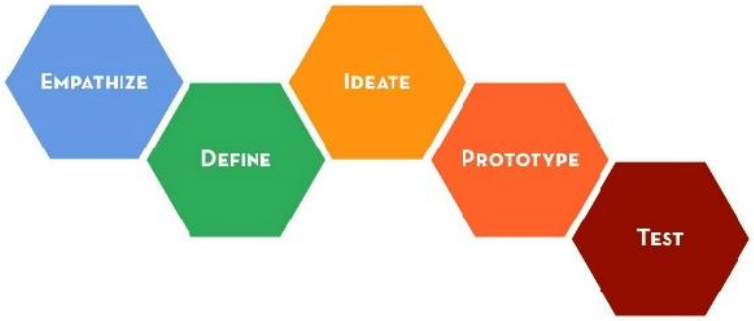

Figure 1. Stages Design Thinking (Stanford d.School)

Then, for an explanation regarding the design thinking method used by the researcher, namely: (1) Empathize stage (building empathy), namely, in this phase, the designer forms a deep understanding of the characteristics and needs of the user (Sekarwulan, 2022). This understanding is formed through empathetic methods such as asking and listening, exploring user experiences, and placing user needs at the center of the design. (2) Define stage (formulating goals), namely, analyzing and understanding the results that have been carried out in the empathize stage (Haryuda et al, 2021). The formulation of goals in design thinking follows the principle of empathy, which states that users and their needs are specifically considered. (3) Ideate stage (ideation, creating solutions), namely, the designer creates solution ideas. With this, the process of generating ideas in design thinking is structured to yield as many solution ideas as possible.

Next, in (4) Prototype stage (developing a prototype), namely the initial design that will be made, which will be tested on users to obtain appropriate responses and feedback to refine the design (Khair et al. 2023). The prototype stage is the time to design and build a model that demonstrates the solution's features. In this model, it is called a prototype and can be used to quickly test and validate ideas, allowing product improvements to be made before it is actually tested. Furthermore,

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(5) Test phase stage (testing the Prototype), namely, testing is carried out to collect various user feedback from Various final designs formulated in the previous prototyping process (Hartina et al., 2022).

This study involved 25 students and 3 mathematics teachers. The study was conducted at junior high schools: SMP Al Islam, Mts Fathul Huda, and SMP N 2 Sayung. The three schools are located in the same area in Demak Regency, Central Java Province. The researchers used a questionnaire distribution technique in each school to obtain unique answers from respondents. Data collection used a Google Form questionnaire distributed to three junior high schools/equivalents.

RESULTS AND DISCUSSION

A. *Empathize Phase*

The empathize phase (building empathy) is where the researcher develops a deep understanding of the students' characteristics and needs. In this first phase, the researcher developed a questionnaire and conducted interviews to collect initial data from eighth-grade students and mathematics teachers. Then, the questionnaire and interviews, which had been consulted with experts, were distributed to students and teachers at different schools: SMP N 2 Sayung, SMP Al Islam, Mts Fathul Huda, and others. In-depth interviews were also conducted with several teachers at these schools.

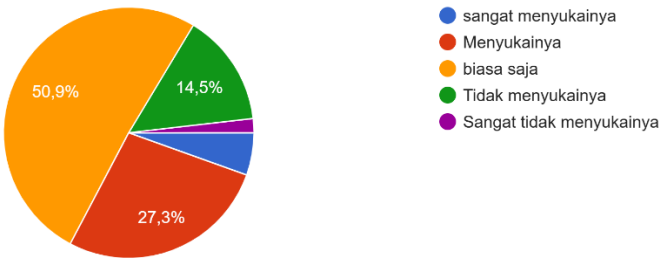

Figure 2. How do you feel when learning mathematics?

From the data above, students' feelings when learning mathematics are as follows: 50.9% of students responded that they liked it, 27.3% of students responded that they did not like it, 14.5% of students responded that they did not

like it, 5.5% of students responded that they really did not like it, and 1.8% of students responded that they did not like it very much. Therefore, the conclusion is that the average student's feelings about learning mathematics can vary. Some feel a lack of confidence and dislike mathematics, while others find it an interesting challenge. Field results indicate a lack of motivation in learning mathematics and low learning outcomes.

Some of the things students like about mathematics are: (a) the teacher; (b) being able to answer questions; (c) teaching aids; and (d) summarizing and calculating. Meanwhile, things students dislike about mathematics include: (a) not liking mathematics; (b) not liking calculating division and multiplication; (c) memorizing formulas; (d) an unconducive atmosphere; (e) difficult material; and (f) everything about mathematics.

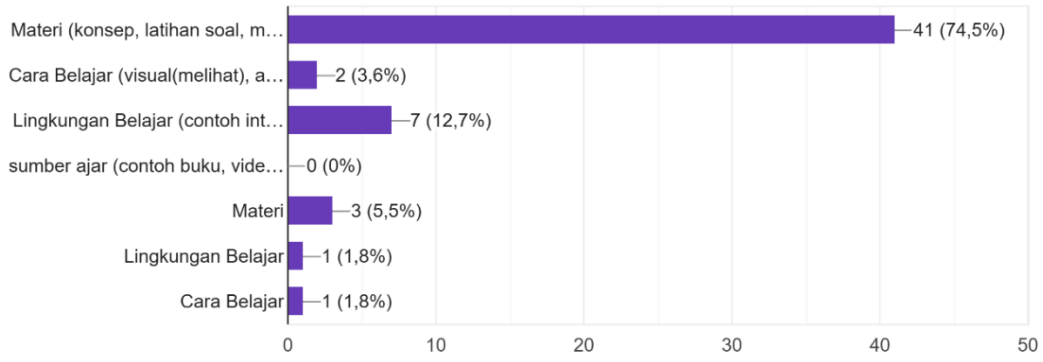

Figure 3. Student Difficulties in Learning Mathematics

From the student respondent data, researchers stated that the biggest difficulty students face in learning mathematics is the material itself. Most students fail to understand concepts and apply mathematical formulas. Consequently, student learning outcomes are not achieved. Based on the data above, the main factors are learning methods and the environment. Teachers need to re-analyze the appropriate curriculum, especially to maximize the use of teaching resources, learning media, Student Worksheets (LKPD), and evaluation instruments. Furthermore, teachers must also consider students' desires and needs. The following are students' desires and needs in learning mathematics: (a) Learning media; (b)

playing math games; (c) interactive media/Android media; and (d) prizes and quizzes.

Based on the student's desires and needs above, the use of interactive media and games in mathematics learning is crucial. Students desire learning that utilizes learning media (Nurlailiyah et al., 2025). This finding suggests that learning problems in mathematics can improve students' motivation to learn and conceptual understanding.

A questionnaire survey of 55 students from SMP N 2 Sayung, SMP Al Islam, and Mts Fathul Huda found that 80% of the difficulties experienced by students were related to the teaching material, 14.5% to the learning environment, and 5.4% to the learning method. Based on the questionnaire results, researchers then analyzed the problems that arose in mathematics learning using empathy maps from students and teachers. The empathy map generated based on the questionnaire and interview analysis is as follows:

Table 1. Student Empathy Map

Say • I like math if I can solve problems. • I think math is difficult. • Math makes me dizzy. • Math is difficult when it comes to formulas. • I do not like math because there are too many formulas. • I like math when it involves calculations. • Math is difficult because there are many complicated and long problems. • I like math when learning uses visual aids. • I do not like math because I often feel sleepy. • Math is important and can be used in the future.	**Feel** □ I am afraid of being wrong if I answer. □ I cannot do math problems. □ I cannot understand the material. □ I am afraid of being asked to do it in front of the class. □ Math is very boring. □ I like math if I can answer math problems. □ Math is very complicated.
Think □ Mathematics is not as easy as it seems. □ Because the answers to math problems are not always correct.	**Do** □ Engaging math learning □ Math is not boring and eliminates drowsiness. □ Math learning uses interactive videos.

Some of the material studied still confuses me about the use of formulas in problems. I do not understand mathematics well enough, so I have not done many problems. I cannot keep up with math lessons. I have difficulty solving math problems. I have difficulty solving story problems. I have difficulty calculating them.	Game-based math learning. Easy-to-understand math examples. Math learning uses visual aids and other tools. Math learning can help students understand the material and solve problems correctly.

Based on the results of the students' Empathy Maps, researchers discovered several things, including:

1. Many students perceive mathematics as a difficult subject due to a lack of conceptual understanding and calculation skills, as well as the fact that mathematics consists of memorized formulas. This leads to confusion and difficulty solving problems posed by teachers during each math lesson. This aligns with Abdurrahman (2010:252), who stated that among the various subjects taught in schools, mathematics is the most difficult for students, both those without learning difficulties and those with learning difficulties.

   When faced with difficulties solving math problems, students believe that discussions with peers and the use of appropriate tools or media are essential to their learning, including internet access and the practical application of the material. In a study by Wulandari et al. (2023), selecting appropriate media can help students understand the material presented by teachers and provide concrete experiences in their learning.

Table 2. Teacher Empathy Maps

Say	**Feels**
• The teacher feels happy when meeting students. • The teacher is enthusiastic as they enter the classroom. • The teacher motivates students to be more enthusiastic about learning mathematics.	• The teacher feels the material is very difficult for students to understand. • The teacher feels the students do not understand mathematics at all.

• Students do not fall asleep during class.	• The teacher feels the students do not understand the formulas they are learning.
Think • Students do not understand the example questions coherently. • Students cannot grasp the material well. • The material being studied is very difficult to understand. • Media such as interactive visual aids or videos are needed.	**Do** • Teachers use interactive media in mathematics learning. • Teachers use teaching aids in mathematics learning. • Teachers use engaging learning methods such as games and audio.

Based on the results of the teacher empathy map above, researchers discovered several things, including:

1. Teachers felt that many students were passive during learning due to a lack of motivation, making it difficult for them to follow and understand the material. This finding is consistent with research by Aryanti and Muhsin (2020), who found that students are more likely to engage in good behavior when motivated. Therefore, it is clear that student engagement in the learning process is influenced by learning motivation, a finding reinforced by Sa'adah and Ariati's (2017) research.
2. In addressing classroom challenges, teachers felt the need to design engaging learning models using internet-accessible tools to facilitate enjoyable learning for both teachers and students. Furthermore, research by Murtado et al. (2023) stated that in learning, the use of online media, or media accessible via the internet, can enhance interaction between teachers and students, facilitate easier access to information and learning materials, and help increase student interest and motivation, thereby improving the efficiency and effectiveness of learning.

B. Define – Formulating Objectives

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The define stage (formulating objectives) involves analyzing and understanding the results of the empathize stage (Haryuda et al., 2021). In this second phase, researchers use the principle of empathy, in which users' needs are specifically stated in a formulation using the point-of-view and How Might We techniques.

1) Defining the problem from *the point of view*

Point-of-View is a method for gathering information from users to generate solution design ideas from their perspective. Point-of-View itself serves to obtain problem statements outlined by users, which will later be used to develop solution design ideas (Sidharta et al., 2022). The following are the results from the student and teacher user point of view:

Student POV

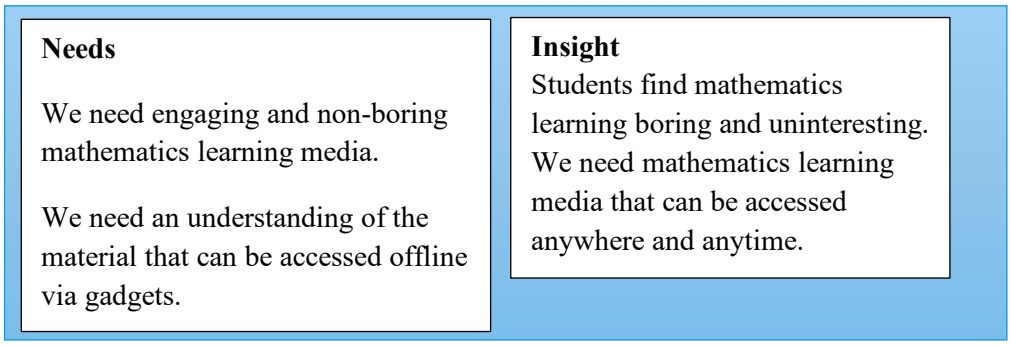

Figure 4. *Point of View* (siswa)

From the student's point of view above, the researcher defined the problem of 55 8th grade student respondents in the independent curriculum through the student empathy map, namely that students consider mathematics lessons to be less interesting and difficult to understand with the main need, namely that mathematics learning requires motivation or encouragement to learn through the presentation of material that can be accessed via their respective gadgets and can be discussed about problem solving and can be practiced so that mathematics learning is easy to understand and not boring.

Teacher POV

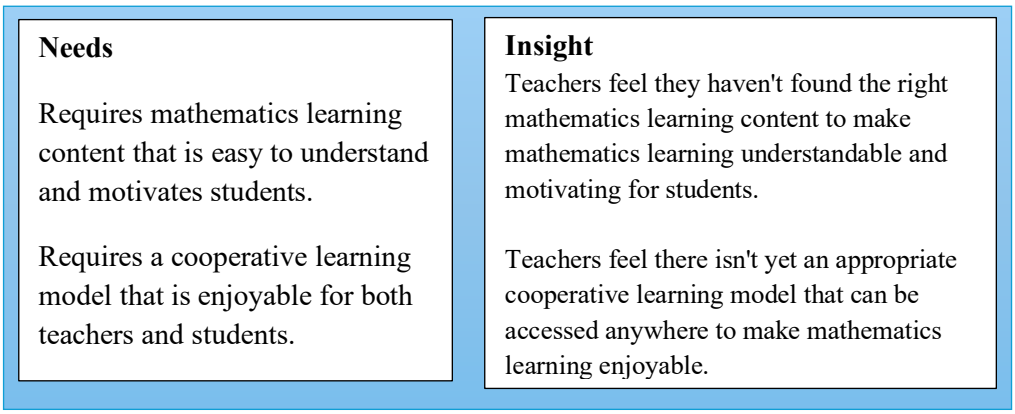

Figure 5. *Point of View* (teacher)

From a teacher perspective, the researcher identified the problem identified by seven 10th-grade mathematics teacher respondents using the independent curriculum through a teacher empathy map. They perceived the material as difficult and difficult for students to understand, resulting in passive behavior and a lack of motivation to learn. Mathematics lessons were uninteresting. The primary need for mathematics learning was motivation or encouragement through accessible presentations on individual devices, discussion, problem-solving, and practical application, making mathematics learning easier to understand and less boring. This aligns with research by Eka Fitria (2021), which shows that using technology-based learning media can foster students' enthusiasm and motivation in class, improve retention, and increase their active participation and feedback during learning activities.

1) *How Might We*

How Might We is a method for generating as many ideas as possible for solutions to a problem or challenge by transforming statements into questions (Saputra and Kania, 2022). Questions and solutions are outlined from the researcher's perspective, based on observations of

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user problems. Each question will have solutions or statements, the formulation of which transforms the problem into a question, thus shifting the mindset that every problem has a solution (Arisa et al. 2023). Therefore, the "how might we" technique helps researchers focus on solving the identified problem. The following is the result of the "how might we" method at the define stage:

How Might We

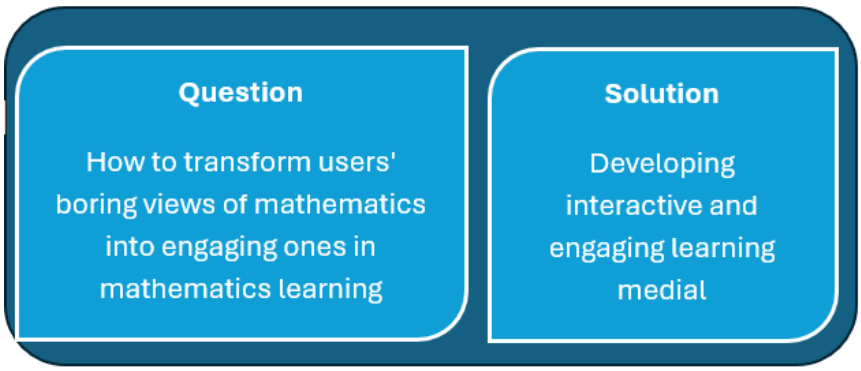

Figure 6. *How Might We*

In the How Might We table, researchers compiled the information needed for each problem solution and how the solutions would be developed. The first question addressed the need for easy-to-understand, engaging mathematics instruction. This aligns with research by Roosita, Lestari, and Setyawan (2022), which found that using interactive media designed to be as engaging as possible increases student enthusiasm and active engagement in the learning process.

C. Ideate – Ideaation, creating solutions

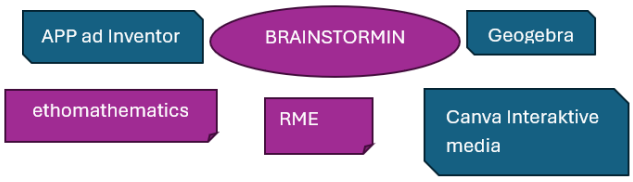

Figura 7. Barinstorming map

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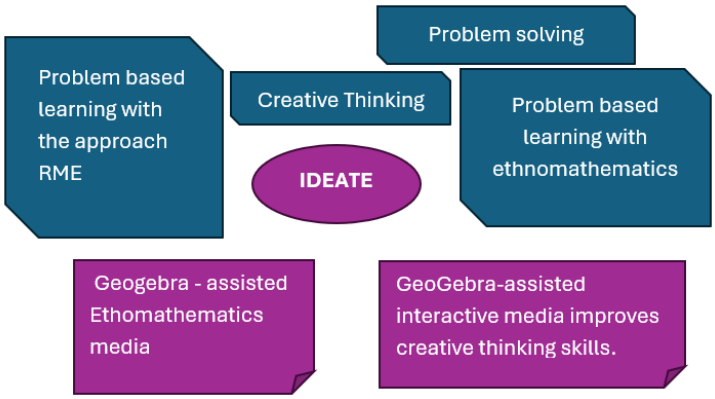

Figura 8. Ideate map

The ideating process involves brainstorming, a technique for gathering input from others to solve problems (Febriansari et al., 2022).

1) Mathematics: Students are less interested in mathematics and find it difficult to understand. Research by Permatasari, K.G. (2021) indicates that mathematics is less appealing to students.

2) Creative Thinking: Based on the empathy stage, students experience anxiety and difficulty thinking creatively. This aims to improve students' creative thinking. This aligns with research by Astria, R., & Kusuma, A.B. (2023), which found that creative thinking skills can improve students' mathematics performance.

3) Problem Solving: Based on the empathy stage, students experience a lack of confidence and difficulty solving problems. This aligns with research by Agustina, A., Azmi, S., & Novitasari, D. (2025), which suggests that it can improve students' mathematical problem-solving abilities.

4) RMR: A realistic mathematics approach can meet students' needs. This research, conducted by Siregar et al. (2020), found that a realistic mathematics approach has been proven to improve creative thinking skills.

5) Problem-Based Learning: a learning model that challenges students to find solutions to real-world problems individually or in groups. Consistent with research by Miria et al. (2022), the application of PBL can improve creative thinking skills.

6) Ethnomathematics: The ethnomathematics approach presents problems related to mathematical culture. Consistent with research (Amalia et al.,

2021), the application of an ethnomathematics-based PBL model can improve creative thinking skills.

7) GeoGebra Media: GeoGebra is dynamic, free, and multiplatform mathematics software. GeoGebra combines geometry, algebra, tables, graphs, statistics, and calculus in one easy-to-use package for all levels of education (Hutagaol, J. E., & Noverica, S., 2025). GeoGebra can produce interactive math applications through the GeoGebra.org website. Therefore, the GeoGebra.org website can be used as an alternative for disseminating GeoGebra-based learning media. This aligns with research (Ramadani et al., 2024), which found that learning media using a scientific approach supported by GeoGebra is highly effective in improving students' creative thinking skills and learning independence.

Thus, researchers have identified various alternative solutions to improve creative thinking skills in mathematics using a design thinking approach based on student needs, teacher needs, scientific and technological developments, and future demands, as follows:

1) Designing PBL learning using the RME approach using GeoGebra;

2) Developing ethnomathematics media using GeoGebra; ethnomathematics is an exploration related to regional culture.

3) Creating PBL learning activities using the RME approach based on ethnomathematics using GeoGebra.

CONCLUSION

The results of the respondent data and problem exploration were analyzed using the design thinking method, conducted at the empathize, define, and ideate stages. The researcher will design and develop interactive media in mathematics learning to improve problem-solving skills. Suggestions for further research include developing interactive media from the prototype stage onward using a design thinking approach.

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