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How do mathematics teachers design tasks to assess students' creative thinking ability?

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ABSTRACT

Abstract This study aims to describe teachers' understanding of designing mathematical tasks to assess students' creative thinking abilities. The descriptive study involved 23 mathematics teachers in a city in East Java, Indonesia. The research Instrument is a task that reveals teachers' understanding of the notion of creative thinking, mathematics' problem of assessing students' creative thinking, some criteria to assess students' creative thinking, and examples of questions designed by the teacher. Data were analyzed descriptive-quantitatively and qualitatively with an iterative method consisting of data condensation, data display, and data verification. The study results indicate that teachers' understanding of creative thinking is still lacking, how to assess, and assessment criteria, their abilities still need to be improved.

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INTRODUCTION

Mathematics is a means of scientific thinking and plays a role in the development of pure sciences and social sciences (Surat, 2016). Mathematics learning aims to foster logical, rational, critical, creative, systematic, and practical ways of thinking (Ha & Ha, 2022; Hartono, 2020). Thinking creatively in mathematics and other fields is a skill that must be developed in facing the information age and increasingly fierce competition (Andiyana et al., 2018). Someone needs to be able to think creatively because it makes easier to deal with problems. Teachers can educate students to think creatively so that students will be able to facechallenges, and conversely students who are not given the opportunity to think creatively will become frustrated and dissatisfied with the process going forward.

The ability to think creatively is a component of the *Pancasila* student profile which is the goal of mathematics education today (Sadieda et al., 2022). This ability needsto be imparted to students in the 21st century (Juniarso, 2020; Newton & Newton, 2014). Consideringcreative thinking as the focus of education in our country, it is necessary to cultivate and improve students' creative thinking skills. In order to achieve the goal, it is necessary to see how the teacher's ability to develop creative thinking in learning mathematics. The reason is that the teacher is the first person to cultivate students in schools so that they can achieve one of our country's educational goals and one of the *Pancasila* student profiles.

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The importance of having the ability to think creatively in everyday life is to actualize oneself, develop the ability to see several possible solutions of the problems, provide self-satisfaction, and improvethe quality of life (Munandar, 2009). It can be seen that creative thinking is important to havein all fields, especially in the field of education. Creative thinking in the field of educationhas an important role in increasing one's global insight to face globalization (Mustari & Rahman, 2014). For this reason, a teacher needs to have the ability to think creatively in order toprovide innovative learning so that students have that ability as well, so that students are ableto face challenges in the future. Learning mathematics at school has an important role to encourage studentsto think logically and creatively in solving problems and making decisions (Sa'dijah, 2014). Inthis case, education can be said as a place to facilitate someone to develop their creative thinking abilities.Recently, some teachers have complained that students' creative thinking abilities, especially in learning mathematics, are still low (Kadir & Satriawati, 2017; Puspitasari et al., 2018). Moreover, Meika & Sujana (2017) state that high school students' creative thinking and mathematical problem solving abilities were still low. This is caused by the process of learning mathematics which still tends to bemonotonous. The role of the teacher here is very important to foster creative thinking skills in students,which means that learning mathematics is not just counting and teacher centered. Teachers musthave knowledge in creative thinking, especially in learning mathematics. In addition, here the teacherhas an important role in stimulating creativity in classroom learning (Levenson, 2013). Teachers usuallyattribute the importance of logic to learning mathematics, and often ignore the power of creativity (Pehkonen, 1997). Many researchers mainly Bolden et al. (2010) and (Shriki, 2010) have confirmed thatteachers' overall knowledge of creativity is very limited and narrow. This can be seen from the teacher'sperception on creativity which seems to focus more on the concept of teaching creatively than teaching for creativity.

Creative thinking in mathematics refers to the notion of creative thinking in general. Pehkonen (1997) explains that a person needs two different complementary thinking models in mathematics, namely creative thinking which is intuitive and analytical thinking which is logical. This view sees creative thinking as an intuitive thought rather than a logical one. This understanding shows that creative thinkingis not based on logical thinking but rather as a thought that suddenly appears, is unexpected, and is out of the ordinary. (Pehkonen, 1997) views creative thinking as a combination of logical thinking and divergent thinking which is based on intuition yet awareness. When someone applies creative thinking in a problem solving practice, intuitive divergent thinking generates many ideas. This will be useful in finding the solution. This explains that creative thinking pays attention on logicaland intuitive thinking to generate ideas. Therefore, in creative thinking two parts of the brain will be very necessary. The balance between logic and intuition is very important. If you place too much logical deduction, creative ideas will be neglected. Thus to bring out creativity requires freedom of thought not under control or pressure. This view is more towards the second view in the sense of creative thinking

(Krulik & Rudnick, 1999) explain that creative thinking is thinking that is original, reflective, and produces a complex product. Such thinking involves synthesizing ideas, constructing new ideas and determining their effectiveness. In addition, it also involves the ability to make decisions and produce new products. This definition does not mention that creative thinking is only intuitive apart from logical thinking and does not explicitly mention creative thinking as a synthesis or combination of logical thinking and intuitive divergent thinking. This implies that creative thinking more as a whole inwhich there are logical and divergent thinking processes that support each other and are inseparable.

Creative thinking is the process of producing a creative product which is a new (innovative) work that is obtained from one or more activities that are directed according to purpose (Weisberg, 2006). Furthermore, creative thinking also involves intensive production that fulfills novelty, so that someone can be said to be creative by producing something that was not known before. The terms creative thinking and creativity always appear together. (Pehkonen, 1997) explains that creativity emphasizes products, which means creativity as performance where the individual is producing something new and unpredictable. Tan (2015) regards creativity as an effective combination of divergent and convergent thinking. Operationally, this view leads to a definition of creativity based on four related components, namely fluency, flexibility, novelty, and elaboration.

Balka (1974) introduced criteria for measuring mathematical creative ability. He discusses both convergent thinking, characterized by setting patterns and breaking down established thought patterns,

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and divergent thinking, defined as formulating mathematical hypotheses, evaluating unusual mathematical ideas, sensing what is missing from problems, and breaking general problems into specific sub problem. In reviewing Balka's criteria, breaking from the established mindset is a defining feature in others' efforts to understand the creative mathematician. In addition to these concepts, Imai (2010) adds elaboration (expanding or improving) methods and sensitivity (constructive criticism of standard methods).

Derek (1997) and Krutetskii (1976) believe that overcoming fixations is necessary for creativityto emerge. Both, focus on solving the mental sets that limit the problem solver's creativity. Limits are also set when creativity and systematic application are confused. In the previous work, (Derek, 1997) discussed the difference between creativity and systematic problem solving in mathematics. By applying learned strategies, a student can systematically apply several methods to solve a problem but never deviates into a creative strategy, never exploring areas beyond what the individual knows about the content-universe. To encourage the development of mathematical creativity, educators need to enable creative exploration and reward students who seek to expand their content-universe.

One of the teacher's tasks related to creative thinking is to measure students ability to use creative thinking (Siswono, 2011; Siswono et al., 2018). Studies of mathematical creativity mainly Derek (1997) and Bicer et al. (2020) have attempted to measure mathematical creativity in terms of both flexibility, fluency and the originality of students' responses to the problems presented or reviewed from the development of mathematical problems from situational data. (Silver, 1997) also provides indicators to assess students' creative thinking (fluency, flexibility, and originality) using problem posing and problem solving. Fluency is the ability to generate a large number of thoughtsor questions. Flexibility is the ability to generate many thoughts. Originality is the ability to think in new ways or with unique expressions. Based on the description above, this study aims to describe teachers' understanding in designing mathematics assignments to assess students' creative thinking abilities.

METHOD

Based on the research objectives above, this research includes descriptive-exploratory research to describe teachers' understanding in designing mathematical assignments to assess students' creative thinking abilities. This research involving 23 junior high school mathematics teachers in one of the city in East Java, Indonesia. The duration of teaching of the participants are varies, ranging from 6 to30 years (see Table 1).

Table 1. The participants of the research

Gender	Percentage (%)	Years of teaching experience		
		6-10	11-20	21-30
Male	47,8	21,7%	17,3%	13%
Female	52,2	5,3%	21,7%	22%

The research instrument was a fill-in assignment that revealed the teacher's understanding of the meaning of creative thinking, assessed creative thinking skills assignments, criteria questions for assessing creative thinking skills, and examples of questions designed by the teacher. Indicators of creative thinking skills in this study include fluency thinking skills, flexible thinking skills, and original/novel thinking skills (Mann, 2006). Fluent thinking skills refer to the number of ideas generated in response to an instruction or question. The sub-indicators of fluent thinking skills are asking various questions, answering questions promptly and correctly, having many ideas about a problem, and quickly estimating calculation results. Flexible thinking skills appear by changing in approach when responding to instructions. Students' flexible thinking skills in solving problems in different ways can show students' creative thinking skills (Mann, 2006; Plucker & Beghetto, 2004; Sriraman, 2009). The sub- indicator of flexible thinking skills is providing various alternative ways of solving problems, giving consideration to situations that are different from those given by other people. Furthermore, novelty is the originality of ideas created in response to instructions. Sub-indicators of original thinking are thinking about problems or things that are rarely thought by other people, having a way of

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thinking that is relatively different from other people, enjoying reading or listening to ideas to find solutions that are relatively original. The instrument for creative thinking skills was developed from these sub- indicators.

Data collection was carried out by means of a questionnaire via the Google form. It consisted of two questions and examples of teacher design questions. Data were analyzed quantitative descriptively and qualitative using iterative methods, consisting of data condensation, data exposure, and data verification. The questions given are flexible and adapted to the context and focus of the problem for the purpose of exploring the opinions and thoughts of the participants. Aspect of the question described on Table 2.

Table 2. Aspects of the questions given

Topics	Questions
Creative thinking	What is meant by creative thinking?
Assessing creative thinking	How to assess creative thinking? Give an example of math problems to assess the creative thinking abilities of junior high school students!

RESULTS AND DISCUSSION

In this study, data was collected through a questionnaire consisting of questions on the definition of creative thinking, assessing creative thinking and giving an example of math problems to assess the creative thinking abilities of junior high school students. The results of the questionnaire for each question (see Table 3) will be explained as follows:

Creative thinking in mathematics

Table 3. Teacher's views regarding creative thinking in mathematics

Definition of creative thinking in mathematics	Percentage (%)	Verification result
Students' ability to solve math problems in different ways	8.7	Some teachers still don't know the meaning of creative thinking. They think of creative thinking like problem solving. In addition, some teachers cannot distinguish between creative thinking and creativity.
The ability to connect ideas that have been studiedwith a new idea	17.4	
Students can solve material-related problems and can apply them in everyday life	21.7	
Students' ability to solve mathematical problemsStudent creativity in solving a problem	30.4 21.8	

The results of data analysis and reduction of teachers' knowledge about creative thinking in mathematics show that teachers' knowledge is still low. Around 26.1%of the teachers have correctly explained the meaning of creative thinking. They define creative thinking as students' ability to solve math problems in different ways and the ability to connect ideas that have been studied with a new idea. For example, the teacher's answer explains that "creative thinking is the ability to think about finding math answers in ways that are easy for them to understand and it is on their own way." However, 73.9% were incorrect in answering the definition of creative thinking. The findings show teachers describe the definition of creative thinking as students can solve material-related problems and can apply them in everyday life as many as 21,7%, and students' ability to solve mathematical problems as many as 30,4%. For example the teacher's answer states "creative thinking is the ability of students to solve math problems in everyday life". Teachers as many as 21.8% think of creative

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thinking similar to problem solving. For example theteacher argues that "creative thinking is the ability of students to solve problems with their creativity".

Assessing creative thinking

Table 4. Teacher's views on assessing creative thinking in mathematics

How to assess creative thinking in mathematics	Percentage (%)	Verification result
Adapted to indicators of creative thinking	13	They still do not know the indicators of creative thinking assessment in learning mathematics. Even though there were some teachers who mentioned the word indicators for assessing creative thinking, they could not mention it. Then for the criteria for creative thinking questions, some teachers mentioned open ended questions.
By giving open-ended problems or having multiple answers	26	
By looking at the results of student answers, using the completion strategy chosen by the student	26	
By observing, analyzing students in the process of solving problems	35	

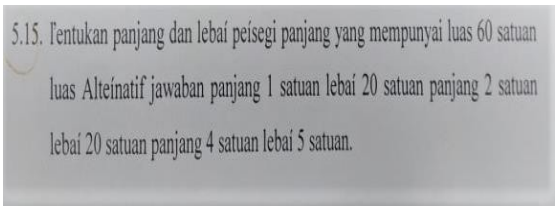
In this case, the teacher's view of the assessment of mathematical creative thinking in mathematics learning is still unclear. This can be seen 26% from the number of teachers' answers, they tend to analyze student answer strategies and create open ended questions for assessing students' creative thinking. Based on the teacher's view, which gives more answers regarding indicators for assessing creative thinking as many as 13% teacher said that "the assessment is adjusted to indicators of creative thinking". Even so, he couldn't mention the indicators of his assessment. On the other hand, 26% teachers also argues that the assessing is by looking at the results of student answers, using the completion strategy chosen by the student. Based on the teacher's answer, namely, "one way is to look at the results of student answers, using the completion strategy chosen by the student". The most answer (35%) is by observing and analyzing students in the process of solving problems.

Teacher design task

Based on the results of the teacher design task, many teachers still provide examples of creative thinking task questions not based on creative thinking assessment criteria (fluency, flexibility, and originality). There were 17.3% of teachers who gave examples of questions with fluency criteria and 82.7% did not fulfill fluency, flexibility, and originality. The following will show some examples of questions made by teachers who meet the fluency criteria and examples of questions that do not meet the fluency, flexibility and originality criteria.

Criteria fluency

Example 1

 5.15. Tentukan panjang dan lebai peisegi panjang yang mempunyai luas 60 satuan luas Alteínatif jawaban panjang 1 satuan lebai 20 satuan panjang 2 satuan lebai 20 satuan panjang 4 satuan lebai 5 satuan.	Translate Find the length and width of a rectangle that has an area of 60 square units! Alternative answers are 1 unit long, 20 units wide, 2 units long, 20 units wide, 4 units long, 5 units wide

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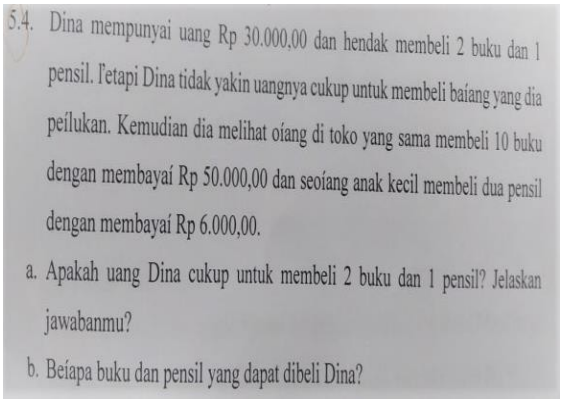
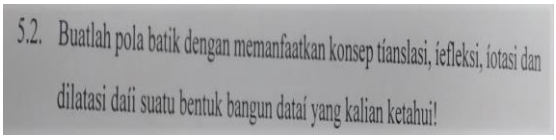
Example 2

 5.4. Dina mempunyai uang Rp 30.000,00 dan hendak membeli 2 buku dan 1 pensil. Tetapi Dina tidak yakin uangnya cukup untuk membeli baíang yang dia peílukan. Kemudian dia melihat oíang di toko yang sama membeli 10 buku dengan membayaí Rp 50.000,00 dan seoíang anak kecil membeli dua pensil dengan membayaí Rp 6.000,00. a. Apakah uang Dina cukup untuk membeli 2 buku dan 1 pensil? Jelaskan jawabanmu? b. Beíapa buku dan pensil yang dapat dibeli Dina?	Translate Dina has Rp. 30,000.00 and wants to buy 2 books and 1 pencil. But Dina isn't sure she has enough money to buy the things she needs. Then he saw a man in the same shop buying 10 books for Rp.50,000.00 and a small child buying two pencils for Rp. 6,000.00. a. Is Dina's money enough to buy 2 books and 1pencil? Explain your answer? b. How many books and pencils can Dina buy?

Examples that do not meet the criteria for fluency, flexibility, and originality

Example 3

 5.2. Buatlah pola batik dengan memanfaatkan konsep tíanslasi, íefleksi, íotasi dan dilatasi daíi suatu bentuk bangun dataí yang kalian ketahui!	Translate Make a batik pattern using the concepts of translation, reflection, rotation, and dilation of a flat shape that you know!

Example 1 and 2 show the teacher's design task which is included in the fluency criteria because these questions can bring up many answers. In example 1, the answers that appear include 1 unit long, 20 units wide, 2 units long, 20 units wide, 4 units long, 5 units wide. Meanwhile in the example 2, the answers that appear are Dina can choose 4 books and 3 pencils, 5 books and 1 pencil, 2 books and 6 pencils, 1 book and 8 pencils. Because many answers emerged, the fluency criteria emerged in this assessment. Inaddition, the criteria for flexibility and originality are still not visible in examples 1 and 2. Then for example 3, the teacher's view is still unclear regarding the design of the task. Example 3 does not show the assessment of the criteria for fluency, flexibility, and originality.

From the results above it can be seen that the teacher's views regarding students' creative thinking are still relatively low, only 26,1% of teachers' answers about definition of creative thinking are correct. They has difficulty in explaining the definition of creative thinking and they cannot distinguish between creative thinking and creativity. In line with this research, (Shriki, 2010) argues that teachers' knowledge about creative thinking is lacking. However, teachers regard themselves as a key factor in developing mathematical creative thinking (Kattou et al., 2009), not as an obstacle to the creativity. In terms of stifling creativity, teachers tend to blame the education system. Although creativity plays an important role in mathematics, it remains undervalued in the context of math classes (Yazgan-Sag & Emre-Akdogan, 2016). Teachers' awareness and knowledge of creativity also have a major impact on fostering student creativity (Runco, 2008). However there is insufficient teacher awareness of tasks that may require mathematical creativity (Levenson, 2013). A math assignment may be inherently creative on its own, but its creative aspects may not materialize if the teacher is unable to facilitate creative approaches in class (Panaoura & Panaoura, 2014).

From the results regarding the correct definition of creative thinking, some teachers actually already understand this definition. This can be seen from the teacher's answer, namely the definition of creative thinking is the ability to connect ideas that have been studied with a new idea. In this case,

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according to Levenson (2013) that teachers can also demonstrate new concepts with previously learned concepts, reframing past experiences in ways that can lead to new insights. Teachers are responsible for fostering an environment where students feel safe, where they can challenge teachers' beliefs without fear of repercussions and propose new ideas that may seem unconventional (Runco, 2008). Finally, as previously mentioned, the teacher chooses which types of assignments to implement and which problems to pose. In addition, being willing to deviate from planned activities, modifying existing assignments, and tending to unexpected questions can also encourage students to create their own new ideas. So, it is not only the type of activity but how the activity is carried out that can increase mathematical creativity (Levenson, 2013).

The incorrect answers related to the definition of creative thinking, one of which is that the teacher defines creative thinking as the ability to solve math problems. According to Sriraman's definition, (Nadjafikhah et al., 2012) at the school level, some researchers believe that creativity in mathematics is generally associated with problem solving or problem posing (Chamberlin & Moon, 2005; Liljedahl & Sriraman, 2006; Silver, 1997; Sriraman, 2009). Plucker & Beghetto (2004) consider creativity as an important component of problem solving.

Furthermore, the teacher's view regarding the creative thinking assessment indicators shows that the teacher has not emphasized assessments that lead to students' creative thinking abilities because some teachers do not understand the indicators in the assessment of creative thinking. In line with the results of this study, Bolden et al. (2010) has confirmed that teachers' overall knowledge of creativity is very limited and Shriki (2010) added that some teachers' views on creative thinking are verynarrow.

The teachers described the assessment of creative thinking as by observing, analyzing students in the process of solving problems, namely as much as 35%. According to Yazgan-Sag & Emre-Akdogan (2016) concluded that prospective mathematics teachers define the characteristics of creative students based on their approach to problem solving and their thinking style. Teachers, on the other hand, emphasize the importance of solving problems with different methods, as well as maintaining continuityin generating new ideas. Yazgan-Sag & Emre-Akdogan (2016) also concluded that teachers regard the ability to maintain continuity when generating new ideas as a sign of creativity. He also found that prospective teachers have different perspectives of creativity in their teaching practice.

For the teacher's ability to design math problems, the questions that the teacher made met the fluency criteria of 17.3% and the rest of the teachers did not meet the flexibility and originalitycriteria. Many teachers who design math problems are still unclear and need to be improved again according to the editor's assessment of creative thinking. This is in line with the research of (Alwi & Murtianto, 2022) that the teacher designs math problems on the criteria of fluency, namely the teacher gets ideas from the subject matter being able to make mathematical models and is able to make other examples of similar cases correctly and smoothly. This is in line with the opinion (Pratiwi & Harun, 2021) that teachers can provide many ideas for answers or ideas for relevant questions and their solutions correctly and clearly.

The findings discussed here suggest that the meaning of creative thinking in mathematics is unlikely to be well understood by teachers. This situation might receive improvement if teachers understand the meaning of creative thinking in mathematics is explored explicitly. Teachers tend to encounter misconceptions and narrow conceptions about the definition of creative thinking and how to evaluate it in mathematics. In addition, even though several teachers have shown an assessment using fluency criteria, there are still many teachers who do not know the assessment of creative thinking, especially fluency and originality. Consequently, teachers may need to give creativity in mathematics more explicit attention so that these weaknesses can be overcome and confronted (Strauss, 2010; Tillema, 2007).

CONCLUSION

The conclusion of this study is that teachers' views regarding the notion of creative thinking are low, only 26,1% of the teachers' answer about definition of creative thinking is correct. Then, they don't know the assessment indicators and design of creative thinking questions in learning mathematics. Teachers need to improve their ability to understand the criteria for assessing students' creative thinking indicators in learning mathematics because teacher just made met the fluency criteria of 17.3% and the

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rest of the teachers did not meet the flexibility and originality criteria. So that teachers can manage the learning processes in the classroom and can design appropriate mathematics assignments to assess students' creative thinking abilities.

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REFERENCES

Alwi, A. A. R., & Murtianto, Y. H. (2022). Profil kemampuan berpikir kreatif matematis mahasiswa UPGRIS calon guru matematika ditinjau dari multiple intelligences. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *4*(4), 276–283. https://doi.org/10.26877/IMAJINER.V4I4.9913

Andiyana, M. A., Maya, R., Hidayat, W., Siliwangi, I., Terusan, J., Sudirman, J., Cimahi, J., & Barat, I. (2018). Analisis kemampuan berpikir kreatif matematis siswa SMP pada materi bangun ruang. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(3), 239–248. https://doi.org/10.22460/JPMI.V1I3.P239-248

Balka, D. S. (1974). Using research in teaching: Creative ability in mathematics. *The Arithmetic Teacher*, *21*(7), 633–636. https://doi.org/10.5951/AT.21.7.0633

Bicer, A., Lee, Y., Perihan, C., Capraro, M. M., & Capraro, R. M. (2020). Considering mathematical creative self-efficacy with problem posing as a measure of mathematical creativity. *Educational Studies in Mathematics*, *105*(3), 457–485. https://doi.org/10.1007/S10649-020-09995-8/METRICS

Bolden, D. S., Harries, T. V., & Newton, D. P. (2010). Pre-service primary teachers' conceptions of creativity in mathematics. *Educational Studies in Mathematics*, *73*(2), 143–157. https://doi.org/10.1007/S10649-009-9207-Z/METRICS

Chamberlin, S. A., & Moon, S. M. (2005). Model-eliciting activities as a tool to develop and identify creatively gifted mathematicians. *Journal of Advanced Academics*, *17*(1), 37–47. https://doi.org/10.4219/JSGE-2005-393

Derek, H. (1997). Recognising mathematical creativity in schoolchildren. *ZDM*, *3*(29), 68–74. https://doi.org/10.1007/S11858-997-0002-Y

Ha, H., & Ha, M. (2022). Exploring Korean scientists' perceptions of scientific creativity and education for scientific creativity. *International Journal of Science Education*, *44*(11), 1767–1791. https://doi.org/10.1080/09500693.2022.2095680

Hartono, S. (2020). Effectiveness of geometer's sketchpad learning in quadrilaterals. *Mathematics Teaching-Research Journal*, *12*(3), 84–93.

Imai, T. (2010). The influence of overcoming fixation in mathematics towards divergent thinking in open-ended mathematics problems on Japanese junior high school students. *International Journal of Mathematical Education in Science and Technology*, *31*(2), 187–193. https://doi.org/10.1080/002073900287246

Juniarso, T. (2020). Model discovery learning terhadap kemampuan berpikir kreatif mahasiswa. *ELSE (Elementary School Education Journal) : Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar*, *4*(1), 43. https://doi.org/10.30651/ELSE.V4I1.4197

Kadir, L., & Satriawati, G. (2017). The implementation of ppen-inquiry approach to improve students' learning activities, responses, and mathematical creative thinking skills. *Journal on Mathematics Education*, *8*(1), 103–114.

Kattou, M., Kontoyianni, K., & Christou, C. (2009). Mathematical creativity through teachers' perceptions. *Proceedings of the 33rd Conference of the International Group for the Psychology of Mathematics Education* , 297–304.

Krulik, S., & Rudnick, J. A. (1999). Innovative tasks to improve critical and creative thinking skills. In L. V. Stiff & F. R. Curcio (Eds.), *Developing mathematical reasoning in grades K-12* (pp. 138–145). The National Council of teachers of Mathematics.

Krutetskii, V. A. (1976). *The psychology of mathematical abilities in school children*. University of

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Chicago Press.
Levenson, E. (2013). Tasks that may occasion mathematical creativity: Teachers' choices. *Journal of Mathematics Teacher Education*, *16*(4), 269–291. https://doi.org/10.1007/S10857-012-9229-9/METRICS
Liljedahl, P., & Sriraman, B. (2006). Musings on mathematical creativity. *FLM Publishing Association*, *26*(1), 17–19. https://www.jstor.org/stable/40248517
Mann, E. L. (2006). Creativity: The essence of mathematics. *Journal for the Education of the Gifted*, *30*(2), 236–260. https://doi.org/10.4219/JEG-2006-264
Meika, I., & Sujana, A. (2017). Kemampuan berpikir kreatif dan pemecahan masalah matematis siswa SMA. *JPPM (Jurnal Penelitian Dan Pembelajaran Matematika)*, *10*(2), 8–13. https://jurnal.untirta.ac.id/index.php/JPPM/article/view/2025
Munandar, U. (2009). *Pengembangan anak berbakat*. Rineka Cipta.
Mustari, M., & Rahman, M. T. (2014). *Manajemen pendidikan*. Raja Grafika Persada.
Nadjafikhah, M., Yaftian, N., & Bakhshalizadeh, S. (2012). Mathematical creativity: some definitions and characteristics. *Procedia - Social and Behavioral Sciences*, *31*, 285–291. https://doi.org/10.1016/J.SBSPRO.2011.12.056
Newton, L. D., & Newton, D. P. (2014). Creativity in 21st-century education. *Prospects*, *44*(4), 575–589. https://doi.org/10.1007/S11125-014-9322-1/METRICS
Panaoura, A., & Panaoura, G. (2014). Teachers' awareness of creativity in mathematical teaching and their practice. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, *4*, 1–11. www.k-12prep.math.ttu.edu]
Pehkonen, E. (1997). The state-of-art in mathematical creativity. *ZDM*, *3*(29), 63–67. https://doi.org/10.1007/S11858-997-0001-Z
Plucker, J. A., & Beghetto, R. A. (2004). Why creativity is domain general, why it looks domain specific, and why the distinction does not matter. In R. J. Sternberg, E. L. Grigorenko, & J. L. Singer (Eds.), *Creativity: From potential to realization* (2nd ed., Vol. 39, pp. 83–96). American Psychological Association.
Pratiwi, G. D., & Harun, L. (2021). Profil kemampuan berpikir kreatif matematis siswa ditinjau dari kemandirian belajar kategori tinggi. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *3*(1), 78–87. https://doi.org/10.26877/IMAJINER.V3I1.7184
Puspitasari, L., In'am, A., & Syaifuddin, M. (2018). Analysis of students' creative thinking in solving arithmetic problems. *International Electronic Journal of Mathematics Education*, *14*(1), 49–60. https://doi.org/10.12973/IEJME/3962
Runco, M. A. (2008). Creativity and education. *New Horizons in Education*, *56*(1), 1–8.
Sadieda, L. U., Wahyudi, B., Kirana, R. D., Kamaliyyah, S., & Arsyavina, V. (2022). Implementasi model blended learning pada pembelajaran matematika berbasis kurikulum merdeka. *JRPM (Jurnal Review Pembelajaran Matematika)*, *7*(1), 55–72. https://doi.org/10.15642/JRPM.2022.7.1.55-72
Sa'dijah, C. (2014). Kepekaan bilangan siswa SMP melalui pembelajaran matematika kontekstual yang mengintegrasikan keterampilan berpikir kreatif. *Jurnal Pendidikan Dan Pembelajaran (JPP)*, *20*(2), 222–227. http://journal.um.ac.id/index.php/pendidikan-dan-pembelajaran/article/view/4399
Shriki, A. (2010). Working like real mathematicians: Developing prospective teachers' awareness of mathematical creativity through generating new concepts. *Educational Studies in Mathematics*, *73*(2), 159–179. https://doi.org/10.1007/S10649-009-9212-2/METRICS
Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM*, *3*(29), 75–80. https://doi.org/10.1007/S11858-997-0003-X
Siswono, T. Y. E. (2011). Level of student's creative thinking in classroom mathematics. *Educational Research and Reviews*, *6*(7), 548–553.
Siswono, T. Y. E., Karim, K., Khabibah, S., Hartono, S., & Kohar, A. W. (2018). Mathematical creative thinking and its assessment. *Editorial Staff*.
Sriraman, B. (2009). The characteristics of mathematical creativity. *ZDM - International Journal on Mathematics Education*, *41*(1–2), 13–27. https://doi.org/10.1007/S11858-008-0114-Z/METRICS
Strauss, S. (2010). Teachers' pedagogical content knowledge about children's minds and learning: Implications for teacher education. *Educational Psychologist*, *28*(3), 279–290.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

https://doi.org/10.1207/S15326985EP2803_7

Surat, I. M. (2016). Pembentukan karakter dan kemampuan berpikir logis siswa melalui pembelajaran matematika berbasis saintifik. *Emasains: Jurnal Edukasi Matematika Dan Sains*, *5*(1), 57–65. https://ojs.mahadewa.ac.id/index.php/emasains/article/view/20

Tan, A. G. (2015). Convergent creativity: From arthur cropley (1935-) onwards. *Creativity Research Journal*, *27*(3), 271–280. https://doi.org/10.1080/10400419.2015.1063892

Tillema, H. H. (2007). Promoting conceptual change in learning to teach. *Asia-Pacific Journal of Teacher Education*, *25*(1), 7–16. https://doi.org/10.1080/1359866970250102

Weisberg, R. W. (2006). Expertise and reason in creative thinking. *Creativity and Reason in Cognitive Development*, 7–42.

Yazgan-Sag, G., & Emre-Akdogan, E. (2016). Creativity from two perspectives: Prospective mathematics teachers and mathematician. *Australian Journal of Teacher Education (Online)*, *41*(12), 25–40. https://search.informit.org/doi/abs/10.3316/informit.651369853469752

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