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Students' Mathematical Creative Thinking Ability Reviewed from Metacognition in Integrated Project Based Learning STEM Setting

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Abstract

This study aims to analyze students' mathematical creative thinking ability in terms of metacognition in the STEM integrated project based learning setting. The subjects of this study were taken from class VIII of SMPN 6 Jepara with a purposive random sampling technique. Data collection used in the study used a metacognitive questionnaire, and a written creative thinking test that had been validated with a valid category. The results of the study stated that high students' creative thinking ability had high metacognition, moderate students' creative thinking ability had moderate metacognition, low students' creative thinking ability had low metacognition in the STEM integrated PjBL learning setting. The implication of the study is that teachers can improve their students' creative thinking ability by using STEM integrated project based learning.

INTRODUCTION

In mathematics, creative thinking is nothing new, because mathematicians such as Euclid, Plato, or Mandelbrot have linked mathematics with beauty, creativity or imagination in mathematics (Hendriana et al., 2014). So it can be said, creative thinking plays an important role in learning mathematics, so creative thinking is a skill that needs to be considered (Yanti et al., 2019). Creative thinking in mathematics is very necessary, because creative thinking is important for education in Indonesia in order to create creative young generations.

The ability to think creatively is the ability to generate new ideas to produce a solution to a problem, even get a new way as a new solution. According to Sulistyawati (2018), creative thinking can be taught and developed, starting from the awareness of creative thinking and leading to the application of creative thinking habits (Sulistyawati et al., 2018). The components used to check creative thinking skills consist of fluency, flexibility, originality, and elaboration (Rachmantika et al., 2022). One of the goals of mathematics learning is to increase creative activities involving

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imagination, intuition and discovery, by increasing divergent, authentic thinking, curiosity, creating predictions and guesses and experimenting (Ulfa et al., 2019).

This shows the importance of improving mathematical creative thinking skills through creative activities in mathematics learning. One way to improve students' mathematical creative thinking skills is to use metacognitive learning. Metacognition refers to a person's understanding of their knowledge, so that a deep understanding of their knowledge will reflect its efficient use or a clear understanding of the knowledge in question (Hidayat et al., 2019). Metacognitive knowledge has the capacity to play an important role in student learning achievement (Amin & Sukestiyarno, 2015). Metacognitive learning can improve creative thinking in students.

This metacognitive learning can help improve mathematical creative thinking because it is in accordance with the components of creative thinking skills, namely fluency, flexibility, originality, and elaboration. Efforts that teachers can make to maximize students' creative thinking abilities in terms of metacognition are by applying appropriate learning models. One of the appropriate learning models that is centered on students and can increase student creativity is Project Based Learning.

The Project Based Learning (PjBL) model or project-based learning is a learning model based on student comfort in real-world issues, students find problems, then determine how to solve the problem, then act in collaboration to create problem solutions. The stages of PjBL are determining basic questions, preparing project plans, preparing schedules, monitoring students in project progress, assessing results, evaluating experiences (Rachmantika et al., 2022).

The PjBL model will be more meaningful for students if it is collaborated with a science, technology, engineering, and mathematics (STEM) approach. STEM is a learning approach that connects four fields, namely science, technology, engineering, and mathematics into one unit to develop students' creativity through the process of solving problems in everyday life (Jauhariyyah et al., 2017). STEM involves the "4C" abilities in learning, namely creativity, critical thinking, collaboration, and communication (Nurhidayat & Asikin, 2021).

In addition, Hariyanto et al. (2016) stated that STEM will lead students to do meaningful learning in understanding a concept (Hariyanto et al., 2019). The STEM integrated PjBL learning model is estimated to be able to improve students' creative thinking skills in terms of metacognition compared to other learning models (Chalim et al., 2019). Based on the explanation above, research needs to be conducted to analyze the category of creative thinking skills, as well as the achievement of each indicator of students' creative thinking. The hope from this study is that teachers can determine or plan the use of relevant learning models to improve students' creative thinking skills.

METHOD

This study uses a qualitative approach with a descriptive method, because this study describes a phenomenon or research data systematically and as it is, but the data obtained is in the form of numbers. The subjects of the study were 24 students of class VIII SMPN 6 Jepara. Determination of research subjects using purposive sampling technique, namely determining subjects with predetermined views or qualifications (Sugiyono, 2018). Data were collected using instruments in the form of essay test sheets that were adjusted to the indicators of creative thinking according to Munandar, namely fluency, flexible, original, and elaboration and metacognitive questionnaires (Munandar, 2016). This questionnaire is used to group students based on metacognition, from the results of the questionnaire students are grouped into high, medium, and low categories. The instrument used has been validated with valid and reliable results so that it is suitable for use as a data collection instrument. The data analysis technique applied in this study is the data analysis model based on Miles and Huberman, namely data reduction, data presentation, and drawing conclusions (Sugiyono, 2016).

RESULT AND DISCUSSION

Before giving the students' creative thinking ability test, learning activities were first carried out in class VIII G using the STEM integrated project based learning model. Learning is carried out in six stages according to Banawi (2019). The first stage is determining basic questions, students are invited to explore as many characteristics of students in the class as possible (Banawi, 2019). In groups, students determine basic questions to find the characteristics of their friends in order to get a set of data from anywhere (Science).

The second stage is designing a project plan, students design a project plan that includes where students will go to get data, students note what materials and tools are needed, determine who is responsible, record data and activities carried out (Engineering). The third stage is making a schedule, students and teachers make an agreement on how many minutes to find data. The fourth stage is monitoring students and project progress, students discuss according to their respective groups, and teachers monitor the progress of the project that students have made whether it has gone according to student planning or not. The fifth stage is testing the results, from the data obtained, students test the results to solve the problems contained in the questions (Mathematics).

Students can also check the answers to questions using the "Average Calculator" application (Technology). The sixth stage of project result evaluation, Students present the project result in front of the class, and the teacher provides reinforcement and makes conclusions. At the end of the learning, students are given a metacognitive questionnaire with 25 statement items. The metacognitive questionnaire is used to group students based on their metacognition, namely high, medium, and low. The questionnaire consists of 6 types of metacognitive components, namely declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, and evaluation. Based on the results of the metacognitive questionnaire score, 9 students have high metacognition, 7 students have medium metacognition, and 8 students have low metacognition.

After completing the metacognitive questionnaire, the class is given questions that are worked on individually to measure students' creative thinking abilities. The creative thinking test consists of 5 numbers, each item contains one creative thinking component, namely question number 1 contains the fluency component, which means that students can solve problems by providing more than one idea in making answers. Question number 2 contains the flexibility component, which means that in solving the problem, students provide answers in more than one different way. Question number 3 contains the elaboration component, which means that when working on the problem, students can develop and detail the answer.

Question number 4 contains the originality component, which means that in answering the problem, students provide the answer in their own way. Question number 5 contains the elaboration component, which means that when working on the question, students can develop and detail the answer. From the results of the students' metacognitive grouping, the results of the students' mathematical creative thinking ability test were then seen. The first question contains the fluency component, which means that students can solve the problem by providing more than one idea in making the answer. of the 9 students who have high metacognition, 8 students answered by writing two answer ideas and the results were correct, then 1 more student wrote with two answer ideas but with less precise results. Students with moderate metacognition, as many as 7 students answered by writing one answer idea and the results were correct.

Students with low metacognition, as many as 8 students, where 6 students answered by writing one answer idea and the results were correct, 2 students wrote one idea but the results were less precise. The second question contains the flexibility component, which means that in solving the problem, students provide answers in more than one different way. Of the 9 students who have high

metacognition, 7 students answered in two different ways and the results were correct, 2 students answered in one way and the results were correct. Students with moderate metacognition were 7 students, 6 students answered in one way and the result was correct, 1 student answered in one way and the result was less precise. Students with low metacognition were 8 students, where 5 students answered in one way and the result was correct, 3 students answered in one way and the result was less precise.

The third question contains the elaboration component which means that when working on the question, students can develop and detail the answer. 9 students with high metacognition answered the question in detail and developed the answer with the correct result. 7 students with moderate metacognition, 4 students answered in detail, 3 students did not detail the answer. 8 students with low metacognition, 6 students answered in detail, 2 students did not answer. The fourth question contains the originality component which means that in answering the problem, students provide answers in their own way. Of the 9 students with high metacognition, 6 students answered in different ways and the results were correct, 3 students answered in the same way. Students with moderate metacognition were 7 students, 6 students answered in the same way, 1 student answered in a different way but the results were less accurate.

Students with low metacognition were 8 students, where 6 students answered in the same way, 2 students did not answer. The fifth question contains an elaboration component which means that when working on the question, students can develop and detail the answer. Of the 9 students with high metacognition, 8 answered the question in detail and developed the answer with the correct result, 1 student did not detail the answer. Students with moderate metacognition were 7 students, 4 students answered in detail, 3 students did not detail the answer. Students with low metacognition were 8 students, 7 students answered in detail, 1 student did not answer. The following is an example of a student's answer to question number 1.

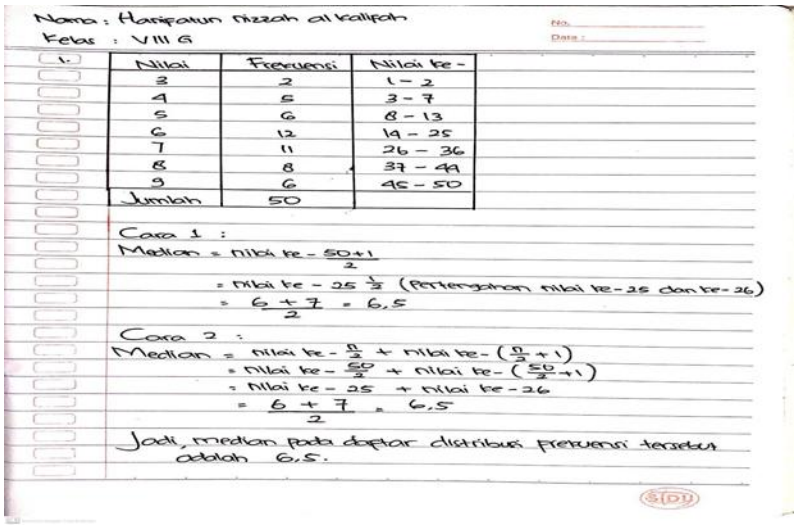

Figure 1. Results of Students' Creative Thinking Ability Test Reviewed from High Metacognition

Based on the test results, students with high metacognition have met the fluency indicator. According to Munandar (2012), students can be said to meet the fluency indicator if they solve problems in many ways and are fluent in using their ideas.

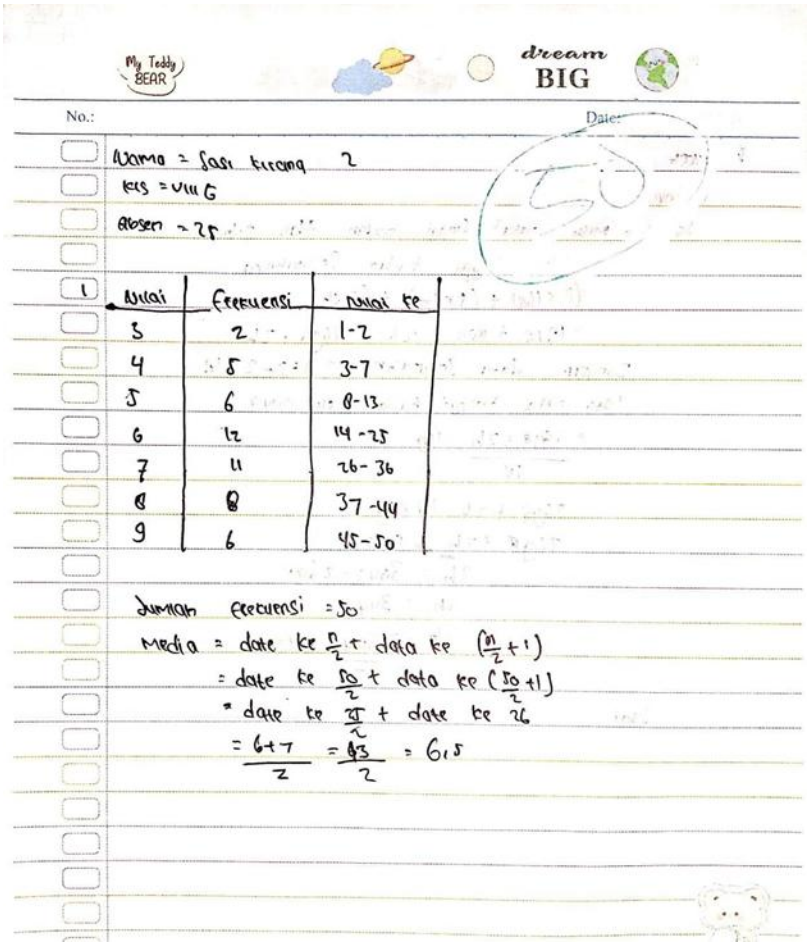

Figure 2. Results of Students' Creative Thinking Ability Test Reviewed from Medium Metacognition

Based on the test results, students with moderate metacognition have not provided many solutions, they only provide one answer, and the answer given is not in accordance with the question given. The lack of student understanding causes errors in solving the problems given. In this case, it means that students are not yet able to provide a solution to a problem smoothly.

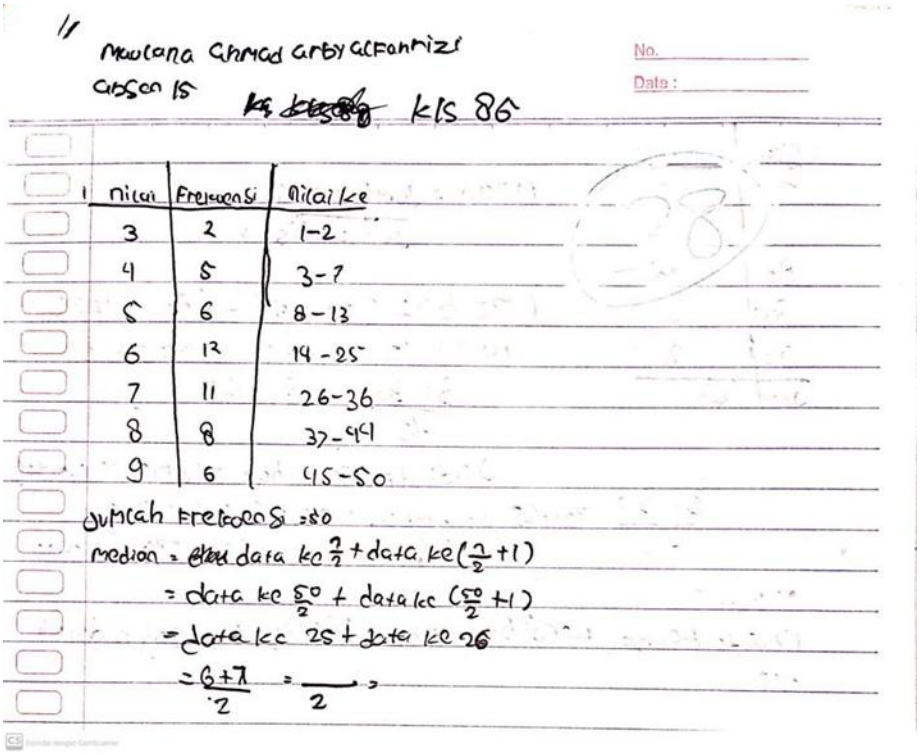

Figure 3. Results of Students' Creative Thinking Ability Tests Reviewed from Low Metacognition

Based on the results of students' answers with a low category on the fluency indicator, it shows that the student has not provided many solutions, he only wrote one answer, and the answer given is not in sync with the question that has been given. The inconsistency of the student's answer is because the student does not understand the question given. In this case, it means that the student has not been able to provide a solution to a problem fluently. Students are considered to have met the fluency indicator if the student can build ideas, and fluency in creative thinking if the student can provide a variety of answers (Anwar et al., 2012).

The selection of learning models also influences training students' creative thinking skills. The type of learning that relates to life or the surrounding environment can sharpen students' creative thinking skills, because students are required to be able to solve problems that arise (Armandita et al., 2017). An environment that is in accordance with the content of the subject matter can expand and clarify the material, concepts, and principles of the subject matter (Febrianti et al., 2016). In addition, constructivist learning designs can hone students' creative thinking skills, because this learning strategy emphasizes student work rather than teacher work, such as conducting practical activities, field studies, discussions, and so on (Wibowo & Suhandi, 2013).

CONCLUSION

Based on the results of data analysis, this study concluded that students' creative thinking skills in solving mathematics problems, especially on quadratic equations, varied according to their metacognitive level.

Students with high metacognition (4 people) showed very good abilities. They were able to fulfill all indicators of creative thinking, namely fluency, flexibility, originality, and elaboration, with an average score of 85 which is included in the high-level creative thinking category.

Students with moderate metacognition (22 people) also showed good abilities, especially in the aspects of fluency, flexibility, and elaboration, with an average score of 77 which is still in the high-level creative thinking category.

Meanwhile, students with low metacognition (4 people) only showed abilities in the aspects of fluency and flexibility, with an average score of 58 which is included in the low-level creative thinking category.

REFERENCES

Amin, I., & Sukestiyarno, Y. L. (2015). Analysis metacognitive skills on learning mathematics in high school. *International Journal of Education and Research*, *3*(3), 213–222.

Anwar, L., Budayasa, I. K., Amin, S. M., & de Haan, D. (2012). Eliciting Mathematical Thinking of Students through Realistic Mathematics Education. *Indonesian Mathematical Society Journal on Mathematics Education*, *3*(1), 55–70.

Armandita, P., Wijayanto, E., Rofiatus, L., Susanti, A., & Rumiana, S. (2017). Analysis the creative thinking skill of physics learning in class XI MIA 3 SMAN 11 Jambi City. *Jurnal Penelitian Ilmu Pendidikan*, *10*(2), 129–135.

Banawi, A. (2019). Implementasi pendekatan saintifik pada sintaks discovery/inquiry learning, based learning, project based learning. *BIOSEL (Biology Science and Education): Jurnal Penelitian Science Dan Pendidikan*, *8*(1), 90–100.

Chalim, M. N., Mariani, S., & Wijayanti, K. (2019). Kemampuan Komunikasi Matematis Siswa SMK Ditinjau dari Self Efficacy pada Setting Pembelajaran Project Based Learning Terintegrasi STEM. *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 540–550.

Febrianti, Y., Djahir, Y., & Fatimah, S. (2016). Analisis kemampuan berpikir kreatif peserta didik dengan memanfaatkan lingkungan pada mata pelajaran ekonomi di SMA Negeri 6 Palembang. *Jurnal Profit*, *3*(1), 121–127.

Hariyanto, H., Yamtinah, S., Sukarmin, S., Saputro, S., & Mahardiani, L. (2019). Penerapan model project based learning (PjBL) terintergrasi pendekatan STEM dalam meningkatkan pemahamahan konsep peserta didik di salah satu sekolah daerah Tangerang Selatan. *Prosiding SNPS (Seminar Nasional Pendidikan Sains)*, 256–261.

Hendriana, H., Slamet, U. R., & Sumarmo, U. (2014). Mathematical connection ability and self-confidence (an experiment on junior high school students through contextual teaching and learning with mathematical manipulative). *International Journal of Education*, *8*(1), 1–11.

Hidayat, Y. N., Wardono, W., & Rusilowati, A. (2019). Analisis kemampuan literasi matematika ditinjau dari metakognisi siswa dalam pembelajaran synectics berbantuan schoology. *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 911–916.

Jauhariyyah, F. R., Suwono, H., & Ibrohim, I. (2017). Science, technology, engineering and mathematics project based learning (STEM-PjBL) pada pembelajaran sains. *Seminar Nasional Pendidikan IPA 2017*, *2*.

Munandar, U. (2016). *Pengembangan kreativitas anak berbakat*. Rineka cipta.

Nurhidayat, M. F., & Asikin, M. (2021). Bahan ajar berbasis stem dalam pembelajaran matematika: potensi dan metode pengembangan. *PRISMA, Prosiding Seminar Nasional Matematika*, *4*, 298–302.

Rachmantika, A. R., Waluya, S. B., & Isnarto, I. (2022). Kemampuan Berpikir Kreatif Matematis pada Pembelajaran Project Based Learning dengan Setting Daring. *Edukatif: Jurnal Ilmu Pendidikan*, *4*(2), 2609–2615.

Sugiyono. (2016). *Metode Penelitian Kunatitatif Kualitatif dan R&D*. Bandung: Alfabeta.

Sugiyono. (2018). *Metode Penelitian kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Sulistyawati, A., Dwijanto, D., & Walid, W. (2018). Analysis of Mathematic Creative Thinking Ability and Metacognition of Student on Probing Prompting Learning Models with Scaffolding Strategy. *Unnes Journal of Mathematics Education Research*, *7*(1), 174–181.

Ulfa, F. M., Asikin, M., & Dwidayati, N. K. (2019). Membangun kemampuan berpikir kreatif matematis siswa dengan pembelajaran PjBL terintegrasi pendekatan STEM. *Prosiding Seminar Nasional Pascasarjana*, *2*(1), 612–617.

Wibowo, F. C., & Suhandi, A. (2013). Penerapan model Science creative learning (SCL) fisika Berbasis proyek untuk meningkatkan hasil belajar Kognitif dan keterampilan berpikir kreatif. *Jurnal Pendidikan IPA Indonesia*, *2*(1).

Yanti, Y., Sumarni, S., & Adiastuty, N. (2019). Pengembangan perangkat pembelajaran pada materi segiempat melalui pendekatan open-ended untuk meningkatkan kemampuan berpikir kreatif. *Jurnal Edukasi Dan Sains Matematika (JES-MAT)*, *5*(2), 145–159.