Student Creativity in Solving Unique Mathematical Problems with Contextual Approach

Ratna Puspitasari 1\* , Sugiman2 

1 Program Study of Mathematics Education, Graduate School, Universitas Negeri Yogyakarta, Indonesia

2 Department of Mathematics Education, Universitas Negeri Yogyakarta, Indonesia

\* Corresponding Author. E-mail: ratnapuspitasari.2021@student.uny.ac.id

|  |  |
| --- | --- |
| **ARTICLE INFO** | **ABSTRACT** |
| Article History:Received: xx-Nov. 2020Revised: xx-Nov. 2020Accepted: xx-Des.2020Keywords:Student Creativity, Contextual Approach, Unique Mathematical Problems*Kreativitas Siswa,* *Pendekatan Kontekstual,* *Masalah Matematika yang Unik*. | Creativity is the ability to make new combinations, or see new relationships between elements, data, or things that already exist. Mathematics plays an important role not only in educating students but also in shaping the characteristics of students, including training them to be creative. The application of a contextual approach to the learning process provides opportunities for students to explore their creativity in solving mathematical problems. This study aims to show students' creativity in solving unique mathematical problems with a contextual approach. The research method used is qualitative research which is a study of literature or literature. Sources of data in the form of journals and related books. The data analysis technique used in this study is qualitative data analysis, which in this study is in the form of opinions expressed by experts. The results of the study show that the contextual approach is one approach that can make students use their creativity during the learning process, especially in solving unique mathematical problems. |
| C:\Users\Ezi Apino\Documents\Pythagoras 2019\Sampel QR Code.png | Kreativitas adalah kemampuan untuk membuat kombinasi baru, atau melihat hubungan baru antara elemen, data, atau hal-hal yang sudah ada. Matematika berperan penting tidak hanya dalam mendidik siswa tetapi juga dalam membentuk karakteristik siswa, termasuk melatih siswa untuk menjadi kreatif. Penerapan pendekatan kontekstual dalam proses pembelajaran memberikan kesempatan kepada siswa untuk menggali kreativitasnya dalam memecahkan masalah matematika. Penelitian ini bertujuan untuk menunjukkan kreativitas siswa dalam memecahkan masalah matematika yang unik dengan pendekatan kontekstual. Metode penelitian yang digunakan adalah penelitian kualitatif yang merupakan studi kepustakaan atau study literature. Sumber data berupa jurnal dan buku terkait. Teknik analisis data yang digunakan dalam penelitian ini adalah analisis data kualitatif, yang dalam penelitian ini berupa pendapat yang dikemukakan oleh para ahli. Hasil penelitian menunjukkan bahwa pendekatan kontekstual merupakan salah satu pendekatan yang dapat membuat siswa menggunakan kreativitasnya selama proses pembelajaran, terutama dalam memecahkan masalah matematika yang unik. |
| This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license  | C:\Users\Ezi Apino\Documents\Pythagoras 2019\creative common.org.png |

How to Cite:

Puspitasari, R., dan Sugiman. (2022). Student Creativity in Solving Unique Mathematical Problems with Contextual Approach. *Pythagoras: Jurnal Pendidikan Matematika*. <https://doi.org/10.21831/pg.v13ixxxxxx>

|  |  |
| --- | --- |
| C:\Users\Ezi Apino\Documents\Pythagoras 2019\logo doi.png | <https://doi.org/10.21831/pg.v13ixxxxxx> |

INTRODUCTION

Mathematics is considered to be one of the most difficult subjects in school because one has to tackle a variety of topics, such as verbal questions, illustrations with mathematical representations, and understanding the relationships between concepts. The material in learning mathematics includes facts, concepts, and skills in solving mathematical problems. Mathematics learning is divided into two, namely mathematics horizontally and vertically (Arifin et al., 2021). Activities of horizontal mathematics:

1. Identify specific mathematics in a general context,
2. Formulate and visualize the problem in different ways,
3. Finding relationships,
4. Finding regularity,
5. Introducing isomorphic aspects in various problems,
6. Turn everyday problems into math problems,
7. Turn everyday problems into familiar mathematical models

While the mathematical activities vertically:

1. Expressing the relationship in a formula,
2. Proving regularity,
3. Repair and customize the model
4. Using different models,
5. Merge and integrate models,
6. Formulate new mathematical concepts,
7. Generalizing formal formsengungkapkan hubungan dalam suatu rumus,

Figure 1 shows the results of students' answers in mathematical activities horizontally. Meanwhile, Figure 2 shows students' answers in mathematical activities vertically (Arifin et al., 2021).



Figure 1. The answers of math activities horizontally



Figure 2. The answers od math activities horizontally

Skills in solving problems are part of life skills (life skills here have been integrated into the world of education) (Haavold and Sriraman, 2021). This is in accordance with Yuliasari's (2017) statement which states that problem solving skills are deemed necessary for students to understand, because these abilities can support students to make appropriate, systematic, rational decisions and consider various perspectives.

Mathematics learning activities are closely related to mathematical problems, because mathematics is one of the subjects that can never be separated from problem solving. However, students still find it difficult to solve mathematical problems. One of these difficulties is because solving a problem requires creativity. Monahan (2002) says that "The majority of people who study creativity agree that problem solving is very important for creative achievement. Most people who really understand creativity believe that it is almost impossible to be creative without problems" (Suastika, 2021). According to Runco et al, creativity can be defined in general as a thought process that produces new and meaningful products (Schoevers et al., 2022). In basic mathematics education, these products, for example, can be ideas that are new to students, problems that have just been proposed, or solutions to problems that are new and meaningful to certain age groups or students. Creativity plays a role when students find a problem that is unique or non-routine. The learning atmosphere affects the creativity of students. Thus, the teacher's role in choosing an approach is very important. If the right approach is chosen, then students can show their creativity. On the other hand, if the approach chosen is not appropriate, students will be hampered in showing their creativity

In essence, learning is a process of interaction between students and the environment, resulting in changes in behavior for the better (Mulyasa, 2013). The learning process will be a place for students to change attitudes, behavior and behavior towards more values ​​and character. The many roles of teaching materials in learning, such as accommodating teaching materials for students and teachers, are the main source of material content, detailed ideas about the basic characteristics of learning, providing knowledge-building materials, and being the main route for teacher development, strategies in learning (Asrizal et al., 2018). The implementation of learning in the classroom is still going on conventionally. Conventional learning is a learning activity where the center of teaching is in the teacher. This learning causes students to be passive and do not develop or express their ideas. Students just listen or imitate in exactly the same way as what the teacher gives without initiative. Students are not encouraged to develop their creativity, so students are not independent in finding material or doing exercises related to solving mathematical problems.

Based on the description previously mentioned, the selection of how to deliver learning materials is still not appropriate. How to deliver the material can be determined by a learning approach. So, a learning approach is needed that can make students learn to be active, self-seeking, and reflective, so that students have an independent attitude in learning and are able to show student creativity. One approach that can arouse students' creativity in solving mathematical problems is the contextual approach. Based on several studies, it was found that the contextual approach is feasible to use as a learning guide and can develop student creativity and improve student learning outcomes (Yeni et al., 2019). In implementing learning using a contextual approach, students are challenged to experience, apply, and transfer new knowledge (Andari, 2012). The contextual approach is an approach that relies on how students are involved in exploring the information asked on the problem which is then linked to conditions in life real (Sanjaya, in Anggoro, 2015). So, a contextual approach can be implemented with the aim that students' creativity can be shown in solving unique or non-routine mathematical problems. In the future, humans are not only asked to solve simple problems, but find solutions with their creativity (Schindler and Lilienthal, 2022).

METHOD

The approach in this study uses the type of research in the form of literature study. The literature study method is a series of activities related to the methods of collecting library data, reading and taking notes, and processing research materials. Sources of data related to research come from scientific journals, literatures, and authors. This literature study was carried out to obtain theoretical information so that researchers have a strong theoretical basis as a scientific result. The data in this study are based on books and journals that are relevant to research. The data analysis technique used in this study is qualitative data analysis where in this study in the form of opinions expressed by experts, these data are used as a basis to strengthen the research arguments compiled.

RESULTS AND DISCUSSION

When facing the 21st century, improving the quality of resources is the nation's main focus. As stated by Greenstein (2012), in the era of globalization to be able to compete in the national and international realm, there are several skills that must be possessed by students as human resources, including:

1. Thinking skills in the form of creative, critical thinking, metacognition and problem solving.
2. Skills in communicating and collaborating/cooperating effectively with various parties;
3. Creativity and innovative skills that can produce innovative breakthroughs;
4. Information and communication technology literacy, these skills are used with the hope of being able to use information and communication technology to develop knowledge and activities in everyday life;
5. Contextual learning skills capable of undergoing self-contextual learning activities as part of personal development; and
6. Information and media literacy skills, namely being able to understand and use various communication media to convey ideas, carry out collaborative activities, and interact with various parties.

Therefore, human resources must have creativity, use technology and information obtained and be able to interpret the meaning of information and become independent learners.

Creativity in general is the production of a novel and an appropriate response, product, or solution to an open-ended task” (Grégoire, 2016). In order to be creative, the result of the product or idea must be different from what existed before. The emergence of ideas or ideas is the result of compiling information and producing different answers following the concepts of flexibility and fluency that exist in creativity (Benedek et al., 2012). Sriraman (2005) defines creativity as (a) a process that results in an unusual (novel) and/or insightful solution to a particular problem or analogue problem, and/or (b) the formulation of a new question. and/or possibilities that allow old problems to be seen from new perspectives that require imagination” (Assmus and Fritzlar, 2022). This statement shows that creativity can be associated with problem solving. For problem solving situations, for example, fluency refers to solving a problem in several ways or finding several solutions to an open problem in a short period of time (Assmus and Fritzlar, 2022). In practice, creativity and mathematics are often considered as opposites, because doing mathematics only involves the use of rational knowledge and the application of rules which of course does not involve creativity (Grégoire, 2016). This can occur as a result of improper education in which mathematics is limited to reproducing and applying knowledge, to the exclusion of exploration and discovery. Creativity in thinking will affect the learning process. As described earlier, the beginning of the learning process is due to curiosity about something. When a student has a problem and wants to solve it, the student will use his mind to analyze any information/facts around him that have a relationship with the problem. Then students can relate the facts they have, then look for alternative solutions so that later they get the desired solution.

Creativity in mathematics has been investigated specifically in relation to mathematics learning (Lu and Kaiser, 2022). In addition, Kattou et al. (2013) identified a positive correlation between mathematical creativity and mathematical ability, such as spatial ability, and inductive/deductive ability, and suggested conceptualizing mathematical creativity as a subcomponent of mathematical ability (Lu and Kaiser, 2022). According to Lubart (2016), in the perspective of problem solving and problem posing, it becomes very clear that creative mathematical activity combines divergent and convergent thinking, because it is about generating diverse responses and further evaluating, selecting, and elaborating ideas based on problem constraints and given criteria (Assmus and Fritzlar, 2022). Thus, several studies state that giving a solution task or solving a problem is used to measure or analyze students' creativity.

One of the teacher's goals is to guide students to develop their creativity. There are research results which state that when someone tries to solve a problem, the individual will first try a solution based on similarities with other problems and consciously evaluate his progress (Haavold and Sriraman, 2021). However, this method often fails because solving problems does not only require comparing similar problems. The process of solving problems apparently requires creative thinking. According to Suherman (2015), creativity certainly does not just appear, so it takes a trigger to awaken one's creativity. Creativity is the result of the individual's own thought process with his environment, which means that the environment has an important role in it. Thus, creativity needs to be supported by activities that make students find ideas/ideas related to the given problem, develop their knowledge, and explore as much information as possible.

Creativity in mathematics is expressed through the following: the new formulation of uncomplicated problems, the discovery of ways and means for solving them, and the discovery of original methods for solving unusual problems. One way to create original thinking situations is to give students open-ended questions that require creative thinking and allow for more than one possible answer. For example, instead of asking "How do we divide 12 apples in 3 bowls evenly?", and the algorithm is firm, we can say, "How do we divide 12 apples among a number of bowls?"; there is more than one answer, and students must make assumptions before choosing the correct answer from different answers (Barnard and and Herbst, 2018). Student creativity has a close relationship with the way teachers teach (Suherman, 2015). Based on this description, the teaching atmosphere and how the learning process takes place have an important role in building students' creativity.

Learning about creativity is an important factor for teachers to help students develop themselves as creative individuals, and prepare them as graduates who have creativity in the workplace, personal life, and society (Sawyer, in Mulyono, 2018). Many countries are working and providing schools as a place to achieve creative learning outcomes. However, there is very little information on how to teach creativity. Wood and Ashfield (2008) argue that in English education, student creativity needs to be developed through the learning and teaching process (Mulyono, 2018). The creativity possessed by students cannot be separated from the level of creativity of the teacher in implementing the learning approach.

The learning atmosphere that is often applied in schools by teachers is still conventional learning. The teacher only asks students to read books to find difficult words and asks them to memorize as many sentences as possible or each student has to remember at least ten words every day without teaching any particular technique how to make it easier and faster or without teaching how to read effectively and more understand. Implementation of conventional learning in the classroom, students do not have to have discussions with their friends. Students are asked to actualize all texts, translate texts and memorize without sharing their ideas and opinions. Thus, the learning process is still not adequate for students to be able to show their creativity in solving problems. According to Suastika (2021), the current learning atmosphere:

1. Learning tends to be teacher-centered.

Mathematics teachers mostly start the learning process by discussing definitions, or simply presenting formulas related to certain topics, followed by discussing examples of questions and ending by asking students to do exercises.

1. Students are less trained in solving open problems that allow many different answers or solutions.

When giving practice, the teacher only gives questions that are routine and closed. Problems are also well formulated which have one correct answer, for example, "Find the volume of the cuboid if its length is 5 cm, its width is 4 cm and its height is 2 cm!" This question is a routine type question because the problem can be solved immediately using routine procedures that have been mastered/understood by students, namely counting 5x4x2". It is said to be "close" because the question has one and only one correct. the answer is 40 cm2.

1. Evaluations that are carried out emphasize more on aspects of mastery of teaching materials, aspects related to students' mathematical creativity are almost never touched.

The choice of approach is one of the factors that determine how the learning process runs. One approach that links learning with student creativity is the contextual approach. The contextual approach is a teaching system that demonstrates learning success when students see meaning in new assignments and materials, and find meaning when they are able to relate new information to their existing knowledge and experiences. Creativity always involves imagination, intuition and discovery by developing different, original and curious thinking, making predictions and guesses, and possibly using trial and error strategies. When students are given real-life problems, they can develop mathematical ideas/concepts and the understanding they have gained and develop ways that lead (close) to context. Furthermore, the points from the real situation can become more general, meaning they can be applied to solve the problem. The fact, this approach gives students access to formal mathematical knowledge. One of the teaching and learning processes that is applied to a contextual approach is that students are asked to relate the problems given to everyday life where this is requires in student creativity. Because the answers given are not listed or explained in detail in the textbook. The answer that the teacher wants is a form of application that students experience in their daily lives.

The difference from the contextual approach to conventional learning is that the conventional approach focuses on a small part of the material and students are given a fixed procedure to complete the exercise and are often individualized. In the contextual approach, learning is broader (complex) and the concepts are meaningful because the questions given are in the form of non-routine questions so that student creativity is needed. Even during the learning process, students are treated as active participants so that they can develop mathematical ideas.

These unique or non-routine mathematical problems will contain problems that are not well structured, so they can refer to activities that have the potential to develop student creativity. There are several reasons why students have difficulty solving unique or non-routine math problems. The first reason is that the concept obtained is still unclear. Solve mathematical problems through a step-by-step process, if the initial steps to solving the problem are not clear, students cannot solve complex problems. If students' basic concepts are not clear, they will not be able to solve complex problems. The second reason is lack of practice. Sometimes students feel they have understood the concept. But when solving problems, they find it difficult to solve the problem. It is important for students to understand a problem then solve it themselves, and practice it every week/month. The third reason is the way the teacher teaches. In mathematics, one problem can be solved by many techniques. Teachers should use techniques that are easy to understand or more procedural so that students can grasp the concept gradually. If the concept is associated with a real-world problem, it will be easy for students to understand the problem. Teachers can use visual methods to describe problems with students. If students don't understand the concept easily, try to change the technique to solve the problem.

The following is one of the results of research that shows students' creativity in solving a unique or non-routine problem. This research was conducted by Wulandari and Afifah (2019). The answer listed in Figure 6 is a solution to the given problem.



Figure 3. The answer of student A

Based on Figure 3, students have met the specified creativity indicators, namely fluency, flexibility, novelty and elaboration. Students are able to mention the smallest trigonometric angle, correctly state the formula, and the solution method mentioned is different from the method in printed books. This proves that the level of student creativity can be shown by giving unique or non-routine problems.

CONCLUSION

Creativity is something that is needed in the learning process, especially in mathematics. In the process of solving mathematical problems, especially on unique or non-routine questions, it requires students' creativity to solve. Because non-routine questions can't be done as usual. These questions need to be done with deep thinking and connected with the creativity of students. The role of the teacher is very important so that students can show their creativity. The learning atmosphere needed is not monotonous and can build interesting ideas for students. Based on the results found, the contextual approach is one approach that can make students use their creativity during the learning process, especially in solving unique math problems.

REFERENCES

Anggoro, R. P. (2015). Pengaruh Pembelajaran Kooperatif Tipe NHT dan TAI dengan Pendekatan Kontekstual terhadap Partisipasi dan Prestasi Belajar Matematika. *Pythagoras: Jurnal Pendidikan Matematika*, *10*, 71–78. <https://doi.org/10.21831/pg.v10i1.9111>

Arifin, S., Zulkardi, Putri, R. I. I., and Hartono, Y. (2021). On creativity through mathematization in solving non-routine problems. *Journal on Mathematics Education*, *12*(2), 313–330. <https://doi.org/10.22342/JME.12.2.13885.313-330>

Asrizal, Amran, and Festiyed. (2018). Effectiveness of integrated science instructional material on pressure in daily life theme to improve digital age literacy ofstudents. *IOP Conference Series: Materials Science and Engineering*. <https://doi.org/10.15294/jpii.v7i4.13613>

Assmus, D., and Fritzlar, T. (2022). Mathematical creativity and mathematical giftedness in the primary school age range: an interview study on creating figural patterns. *ZDM - Mathematics Education*, *54*(1), 113–131. <https://doi.org/10.1007/s11858-022-01328-8>

Benedek, M., Könen, T., and Neubauer, A. C. (2012). Associative abilities underlying creativity. *Psychology of Aesthetics, Creativity, and the Arts*.

Greenstein, L. (2012). *Assesing 21 st Century Skill, A Guide To Evaluating Mastery and Authentic Learning*. Corwin A Sage Company.

Grégoire, J. (2016). Understanding Creativity in Mathematics for Improving Mathematical Education. *Journal of Cognitive Education and Psychology*, *15*(1), 24–36. <https://doi.org/10.1891/1945-8959.15.1.24>

Haavold, P. Ø., and Sriraman, B. (2021). Creativity in problem solving: integrating two different views of insight. *ZDM - Mathematics Education*, *54*(1), 83–96. <https://doi.org/10.1007/s11858-021-01304-8>

Lu, X., and Kaiser, G. (2022). Can mathematical modelling work as a creativity-demanding activity? An empirical study in China. *ZDM - Mathematics Education*, *54*(1), 67–81. <https://doi.org/10.1007/s11858-021-01316-4>

Mulyasa. (2013). *Pengembangan dan Implementasi Kurikulum*. Remaja Rosdakarya.

Mulyono, Y. (2018). Improving Creativity of the Future Physics Teachers Through General Biology Learning Based on CTL with Experimental Method. *Indonesian Journal of Science and Education*, *2*(1), 62. <https://doi.org/10.31002/ijose.v2i1.621>

Schindler, M., and Lilienthal, A. J. (2022). Students’ collaborative creative process and its phases in mathematics: an explorative study using dual eye tracking and stimulated recall interviews. *ZDM - Mathematics Education*, *54*(1), 163–178. <https://doi.org/10.1007/s11858-022-01327-9>

Schoevers, E. M., Kroesbergen, E. H., Moerbeek, M., and Leseman, P. P. M. (2022). The relation between creativity and students’ performance on different types of geometrical problems in elementary education. *ZDM - Mathematics Education*, *54*(1), 133–147. <https://doi.org/10.1007/s11858-021-01315-5>

Suastika, K. (2021). Mathematics Learning Model of Open Problem Solving to Develop Students’ Creativity. *International Electronic Journal of Mathematics Education*, *12*(3), 569–577. <https://doi.org/10.29333/iejme/633>

Wulandari, D. A., and Afifah, D. S. N. (2019). Kreativitas Siswa Dalam Menyelesaikan Soal Matematika Berdasarkan Tingkat Kemampuan Matematika. *Prima: Jurnal Pendidikan Matematika*, *3*(1), 57. <https://doi.org/10.31000/prima.v3i1.770>

Yeni, Y. R., Syarifuddin, H., and Ahmad, R. (2019). The effect of contextual teaching and learning approach and motivation of learning on the ability of understanding the mathematics concepts of grade v student. *IOP Conference Series: Earth and Environmental Science*, *314*(1). <https://doi.org/10.1088/1755-1315/314/1/012064>