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The Analysis of Mathematical Creative Thinking Skill and Independence in Problem-Based Learning With the Open-Ended Approach

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Abstract

The 21st century learning is required to develop 4C capabilities and one of them is creativity. The society that is with the rapid development of information technology needs critical, collaborative, communicative and creative thinking skills. This study aims to determine the characteristics of students' mathematical creative thinking skills in solving mathematical problems in the terms of independence in problem-based learning with the Open-Ended approach. The population in this study was class VII SMP Negeri 14 Semarang. The sampling in this study used cluster random sampling technique. The data obtained from tests of mathematical creative thinking skills, interviews and students' learning independence questionnaires. The conclusion of this study is the independence of student learning in problem-based learning with the Open Ended approach has an influence on the ability to think creatively in mathematics.

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INTRODUCTION

The world, science and technology are always changing and developing. The changes and developments in the world, science and technology need to be balanced with the availability of human resources who have the ability to think logically, critically, creatively and innovatively. The scope of education, especially schools, is a place to prepare human resources who are able to face competition and developments in the world, science and technology. Mathematics is an important subject in school. Mathematics helps students describe the world mathematically and use mathematics to make informed and logical decisions. Mathematics also teaches students to think creatively, structurally and formally (Prianggono, 2013). Through learning mathematics, students are taught to be able to think mathematically.

The ability to think mathematically, especially high-order mathematical thinking is needed by students; it is related to students' needs to solve problems that they face in daily (Noer, 2009). In order to achieve this goal, the current issue in mathematics learning is developing High Order Thinking Skills, abbreviated as HOTS (Noer, 2009). HOTS include critical, creative, logical and reflective thinking. Some of the characteristics of high-order thinking are non-algorithmic, complex in nature, producing multiple solutions, and involving multiple criteria, certainties and self-regulation (Zohar and Dori, 2003). The creative thinking associated with critical thinking is a manifestation of higher order thinking. (Siswono, 2004) says that creative thinking is a process that is used when we come up with a new idea. The experience in the field shows that most students still have difficulty in creating ideas when they are faced with an unusual problem. The low ability of thinking creatively causes students to be unable to solve math problems.

Based on the interview conducted with one of the Mathematics teachers at SMP N 14 Semarang, it is known that most students when faced with math problems will find the difficulty to find solutions. Students need to be guided and taught how to solve math problems so that most students solve problems with the same method or way. This shows that students' creativity in solving math problems is still lacking. Student creativity in solving math problems has not yet grown so that if students are given unusual mathematical problems, they tend to get congestion in channeling the idea of solving these problems.

According to (Nurmasari et al., 2014) creativity can be cultivated, developed and trained with the help of teachers or from other sources and there is a many ways of students in presenting math tasks and it comes from the personal experiences of each student. Creative thinking can be triggered by challenging problems. The method that might be used by the teacher to encourage students' creative thinking skills in mathematics is through problem solving.

Problem solving is one of the goals in learning mathematics. Students are encouraged to reflect on their thinking during the problem solving process so that they can apply and adapt the strategies they have developed to solve other problems in other contexts. Students acquire an original and initiative-filled way of thinking in unusual situations that they face outside of school through solving math problems. Therefore, problem solving and mathematics are an inseparable unit.

Problem solving is an integral part of learning mathematics, so it cannot be separated from learning mathematics (Is, 1998). Zevenbergen (2004) states that problem solving is not just solving problems, it requires development in mathematical thinking. Zevenberg also stated that in solving problems it is necessary to have adequate understanding and knowledge, and having a variety of strategies that can be chosen when facing different problems.

One of the learning strategies that can be accommodated by students in developing creative thinking is Problem-Based Learning with the Open Ended approach. This learning provides a learning strategy with the problem that becomes a basic; it means that learning begins with a problem that must be solved. Problems are raised in such a way that students need to interpret the problem, collect the information needed, evaluate alternative problems, collect the information needed, evaluate alternative solutions, and present the solution. The problem raised is the Open Ended problem, that is a mathematical problem that is structured in such a

way so that it has more than one reasonable answer (multiple reasonable solutions), and more than one reasonable solution (multiple reasonable algorithms and procedures) (Noer, 2009). When students develop a method for constructing a procedure, they integrate concept knowledge with the skills they have.

Each individual has different creative thinking skills in solving mathematical problems. Mathematical creative thinking skills as one of the higher-order thinking skills that must be developed through learning in schools, remembering that creative thinking is one's self-actualization through the ability to solve problems in a unique, beneficial way and enhance one's quality. Meanwhile, students' independent learning must inevitably be a part that must be developed by a teacher. Because a student who has independent learning will try to continue learning, so that he gets satisfaction in the learning process (Nanang, 2016). According to Paris and Winograd (Sumarmo, 2010), the characteristics that contain an independent attitude are awareness of thinking, use of strategies, and sustainable motivation. There are three characteristics in learning independence according to Sumarmo (2010): 1) students design their own learning according to the needs or goals of the student concerned, 2) students choose strategies and carry out their learning plans, 3) students monitor their own learning progress, evaluate learning outcomes and compared to certain standards.

Based on the problems stated above, one of the learning alternatives to overcome the problems of mathematical creative thinking skills and student learning independence is to use a problem-based learning model because it encourages students to learn to make, construct and maintain argumentative and reasonable solutions.

METHOD

This research is a combination research (mixed methods) using a concurrent embedded model. The subjects of this research were students of class VII SMPN 14 Semarang in the 2018/2019 academic year. The sampling technique used was cluster random sampling that is randomly selecting two classes from the population. The experimental class applied problem-based learning to open classes, which ended while the control class applied scientific-based cooperative learning. To measure the research data, the instrument used in the form of an independent questionnaire consisting of 20 items and a creative thinking ability test that represents an indicator of mathematical creative thinking skills, those are: fluency, flexibility, originality and detail. From the two classes that were given the pre-test of mathematical creative thinking skill; then, the normality, homogeneity and average difference of that test were then carried out. The test was used to examine whether the two classes have the same ability or not. The normality test was performed using the *Kolmogorov-Smirnov* test, the homogeneity test used the *Lavene* test, while the average difference test was performed using the independent sample t-test.

RESULTS AND DISCUSSIONS

The results of the data normality pre-test shows that the significance value for the data of students' mathematical creative thinking abilities was 0.140 due to *sig*. = 0.140 = 14.0%> 5% then h_0 is accepted. This shows that the significance value of the experimental class and control class is normally distributed. The homogeneity test with a level of 5% obtained a significance value of 0.388 due to sig. = 0.388 = 38.8%> 5% then H_0 is accepted, it means that the variance of the experimental class is the same as the control class or in other words it also shows that the experimental class and the control class have variances homogeneous. The average similarity test with a real level of 5% obtained a significance value of 0.324 due to sig. = 0.324 = 32.4%> 5% then H_0 is accepted, this shows that the average of initial mathematical skill of the experimental class is the same as the control class or in the other words, both classes have equal initial abilities. The two classes after the treatment were given a creative thinking skill test as many as 8 items in the description obtained by the following table data

Table 1. The Data of Mathematical Creative Thinking Skill

	Experimental Class	Control Class
Students Amount	32	32
Higher Score	97	92
Lower Score	63	61
Average	81.8125	74.1562

The results of the final data normality test shows that the significance value for students' mathematical creative thinking skills is 0.065 due to sig. = 0.073 = 6.5%> 5% then H_0 is accepted, it means that the data on students' mathematical creative thinking skill in the experimental class and control class are normally distributed. The homogeneity test with a real level of 5% obtained a significance value of 0.369 due to sig. = 0.369 = 36.9%> 5% then H_0 is accepted, it means that the variance of the experimental class is the same as the control class or in other words the two classes have homogeneous variances.

The hypothesis in this study is students' mathematical creative thinking skills in problem-based learning with the Open Ended approach are better than students who are with other learning. Based on the average difference test, the $t_{\text{-count}}$ value is 3.44 and the $t_{\text{-table}}$ value is 1.670. Because the value of $t_{\text{-count}} > t_{\text{-table}}$, then H_0 is rejected, so it can be concluded that students' mathematical creative thinking skills in problem-based learning with the Open Ended approach are better than students who are with other learning.

Based on the explanation of the results, it is found that there were differences in students' mathematical creative thinking skill between students who apply problem-based learning with the Open Ended approach and students who do not apply problem-based learning with Open Ended based on student independence. Thus, it can be concluded that problem-based learning with the Open Ended approach has an influence on students' mathematical creative thinking abilities in the experimental class. This confirms that problem-based learning with the Open Ended approach can be used as an alternative in learning for teachers to facilitate students' creative thinking skills.

The learning model used also affects on students' learning independence, such as research by (Faroh et al., 2014) that provides results in the form of increasing student learning independence with student-centered learning, so it makes students active. Problem-based learning with the Open Ended approach applied is learning that strengthens the role of students in the learning process, so that it makes students active. Students' learning independence and teaching and learning activities also increase. The average scores of students' learning independence and creative thinking abilities are shown in the following table.

Table 2. The Average Score of Independence *KBKM*

Group	Average	
	Independence	KBKM
High	73.42	90.17
Middle	72.67	81.4
Low	69.73	73

Based on the table, the difference in the average score of students' learning independence is not too significant in each group. However, the average score for independence is directly proportional to the student's *KBKM*. The learning independence that exists in students will affect the students' teaching and learning activities. The average score for independent learning of students in the lower group is low score, so the *KBKM* scores of students in the lower groups also look low compared to the *KBKM* scores of students in the middle and high groups. The average score of students' learning independence in the high group is good, so the *KBKM* score obtained is also high compared to the average score of the students in the low and middle groups.

This study describes four characteristics of mathematical creative thinking skills; those are fluency, flexibility, originality, and elaboration. On the indicator of fluency, the high group students are able to understand the problem well, solve the problem right and correctly and conclude the problem correctly; likewise students in the middle and lower

groups. However, the low group students still forgot to give conclusions.

For flexibility indicators, high group students can find and write two different alternative answers correctly in solving math problems. Meanwhile, for middle and low group students, they still have difficulty in writing two different alternative answers. They tend to write down a way correctly or write down the same way twice.

On the indicator of authenticity (originality), each group has reached this indicator. Each student has the ability to use a way that is understood and to use her/his own language in solving problems. The fundamental difference in this indicator is the low group students are less structured in their use of language.

In the elaboration indicator, middle and low group students do not yet have the ability to expand and describe mathematical problems. Meanwhile, the upper group has been able to use the ideas that they have

The characteristics of independent learning observed in this study include initiative, creativity, innovation, improvisation, and pro-active. In terms of student's initiative, it is categorized as good. Most students are able to focus and pay attention when learning takes place. Students' enthusiasm in assignments is quite good. Students' creativity and innovation have not looked good. Students seem to have not brought up their creativity and innovation. Meanwhile, students seem to try to do in improvisation. It can be seen from the persistence of students to complete assignments. Students also seem to be trying to work on the problems by providing their own ideas.

In terms of being pro-active, it appears that students are active in learning. All students are able to follow all discussion at the meeting. Some students are able to ask questions when there are problems that they do not understand. The student's activeness can be seen from good teamwork. Problem-based learning has a positive effect in terms of independence. (Silviani et al., 2018) research results show that problem-based learning can improve students' creative thinking skills and learning independence.

CONCLUSION

Based on the results of research and discussion, it can be concluded that the characteristics of mathematical creative thinking in solving problems and posing problems in the aspects of fluency, flexibility, originality, and elaboration are being able to pose and solve problems. The flexibility aspect in solving problems is shown by students by providing other alternative answers. This aspect does not fulfilled in the lower class group of students. All groups of students fulfill the aspect of authenticity in solving and posing problems. The aspect of detail in raising the problem is not fulfilled.

REFERENCES

Faroh, N., Sukestiyarno, & Junaedi, I. (2014). Model Missouri Mathematics Project Terpadu dengan TIK untuk Meningkatkan Pemecahan Masalah dan Kemandirian Siswa. *UJMER*, *3*(2).

Is, W. (1998). Principal and Standart for School Mathematics. *Journal of Equine Veterinary Science*, *18*(11), 719. https://doi.org/10.1016/s0737-0806(98)80482-6

Nanang, A. (2016). Berpikir Kreatif Matematis Dan Kemandirian Belajar Dalam. *Mimbar Sekolah Dasar*, *3*(2), 171–182. https://doi.org/10.17509/mimbar-sd.v3i2.4283

Noer, S. H. (2009). Peningkatan kemampan berpikir kritis matematis siswa SMP melalui pembelajaran berbasis masalah. *Seminar Nasional Matematika Dan Pendidikan Matematika Jurusan Pendidikan Matematika FMIPA UNY, 5 Desember 2009*, 978–979.

Nurmasari, N., Kusmayadi, T. A., & Riyadi. (2014). Analisis Berpikir Kreatif Siswa dalam Menyelesaikan Masalah Matematika pada Materi Peluang Ditinjau dari Gender siswa Kelas XI IPA SMA Negeri 1 Kota Banjarbaru Kalimantan Selatan. *Jurnal ELektronik Pembelajaran Matematika*, *2*(4), 351–358.

Prianggono, A. (2013). Analisis Proses Berpikir Kreatif Siswa Sekolah menengah Kejuruan (SMK) dalam Pemecahan dan Pengajuan

Masalah Matematika pada Materi Persamaan Kuadrat. *Jurnal Pembelajaran Matematika*, *1*(2).

Silviani, R., Belajar, K., & Problem, M. (2018). *Kemampuan Berpikir Kreatif dan Kemandirian Belajar Matematika Siswa melalui Model Problem Based Learning*. *1*(2), 105–116. https://doi.org/https://doi.org/10.31539/judika.v1i2.381

Siregar, E. & Nara, H. 2011.*TeoriBelajardanPembelajaran*. Bogor: Ghalia Indonesia.

Siswono, E. (2004). Identifikasi Proses Berpikir Kreatif Siswa dalam Pengajuan Masalah (Problem Posing) Matematika Berpandu dengan Model Wallas dan Creative Problem Solving (CPS). *Buletin Pendidikan Matematika*, *6*, 1–16.

Sumahamijaya, S., Yasben, D., & Dana, D.A. 2003.*Pendidikan karakter mandiri dan kewiraswastaan: suatu upaya keberhasilan program pendidikan berbasisluas/bord based education and life skills*. Bandung: Angkasa

Sumarmo, U. 2010. Berpikir dan disposisi matematik: apa, mengapa, dan bagaimana dikembangkan pada peserta didik. Artikel pada FPMIPA UPI Bandung.

Zevenbergen, R., Dole, S., & Wright, R. J. 2004. *Teaching Mathematics in Primary Shcool.* Australia: Allen & Unwin.

Zohar, A., & Doni, Y. J. 2003. " Higher Order Thinking Skill and Low Achienving Students: Are They Mutually Exclusive". *The Journal of the Learning Sciences*, 12(2): 145-1