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Mathematical Connection Ability of Grade 8th Students' in terms of Self-Concept in Problem Based Learning

Abdul Kadir✉, Rochmad Rochmad, Iwan Junaedi

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Pascasarjana, Universitas Negeri Semarang, Indonesia

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Abstract

Mathematical connections ability is a demand in mathematics education to develop mathematical ideas and problem-solving in one another. This study aims to find mathematical connection ability patterns in terms of self-concept. The research method used is mixed methods with concurrent embedded design, quantitative research analysis using true experimental design, while qualitative research analysis uses the Miles and Huberman model. The population in this study was eighth-grade students of SMP Negeri 13 Semarang, Indonesia, and sampling was done by random sampling technique. The results showed that the mathematical connection ability pattern in terms of mathematical self-concepts is diverse. It is found that there were two patterns of mathematical connection ability in subjects with high self-concept. In subjects with moderate self-concept, three patterns of mathematical connection ability subjects with low self-concept, three patterns of mathematical connection ability are found.

✉ Correspondence address:
Pascasarjana Universitas Negeri Semarang Kampus Kelud Jalan Kelud Utara III, Semarang
E-mail: abdulkadir2688@gmail.com

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INTRODUCTION

Mathematics is a universal science that underlies the development of modern technology. Mathematics also has an important role in various scientific disciplines and advancing human thought power. In learning mathematics, one particular material can be a prerequisite of another material or one concept may be needed to explain another concept. As an interrelated science, students are expected to have the ability to solve mathematical problems that have links to previously learned material. This ability is called mathematical connection ability.

Mathematical connection ability is one of the abilities that must be possessed by every student. The importance of having mathematical connection skills lies in the secondary school mathematics learning goals (Kemendikbud, 2014), as follows: understanding mathematical concepts and their relationships, and applying them in solving problems precisely and thoroughly. Problem-solving is a major activity in mathematics classes (Rellensmann & Schukajlow, 2017). Furthermore, Rellensmann & Schukajlow (2017) divides problem-solving into two; the problem in mathematical connections with reality (the real world) and connections in mathematics itself. Linto et al. (2012) states that connection skills are important and it should be owned by students so that they are able to connect one material with another material.

Based on the observations results and interviews with mathematics teachers at SMP Kartika III-1 Semarang, it is known that students find it difficult to connect the material that being study and the one that has been studied. Furthermore, the teacher explains the issues in learning mathematics not only in the prerequisite material but also in understanding the basic concepts of mathematics. This is consistent with the research of Linto et al. (2012) which states that in learning mathematics, junior high school students still find it difficult to relate the material they are learning with the prerequisite material that they have learned; concepts that have been learned do not last long in students' memories, resulting in not optimal mathematical connection ability of junior high school students. Similar research was also found by Baki et al. (2009), it is said that the mathematical connection ability of junior high school students was still not optimal, the category of mathematical connections with real-life only obtained 14.7%, which is in the low classification.

Students 'mathematical connection ability was also revealed in Fauzi's (2011) that study of junior high schools (SMP), in general, overall students' mathematical connection abilities are improved but the increase was in the low classification. This is proved by the research results that show the mathematical connection ability of junior high school students through the Metacognitive learning approach which obtains 9.04 average value from previously 9.37 (N-Gain passing grade of 0.33), while junior high school students who study with normal or conventional learning got 24,78 on average mathematical connection ability from previously 9.32 (N-Gain KKM of 0.28). Similar results were obtained by Hendriana et al. (2014), although the progress in the mathematical connection ability of junior high school students taught with a contextual approach, it is better than students' mathematical connection ability taught by conventional learning, an increase in the mathematical connection ability of junior high school students is in the low category. The results of Saminanto & Kartono's (2015) research on the mathematical connection ability of junior high school students stated that the indicators of mathematical concepts are in the medium category with 55%, the indicators linking mathematical concepts with other science concepts are in the low category with a percentage value of 40 %, and indicators linking mathematical concepts with the real world are in the low category with 2%.

In addition to the cognitive aspects, effective aspects are also needed to support the success of students in learning mathematics, one of which is self-concept. Self-concept has an important role in solving problems, both in daily

life or in educational attainment and other academic achievements (Seaton, 2014). Self-concept is a view of self that each individual has towards others. Musriandi (2017) revealed that self-concept is a person's self-image about himself consisting of physical (appearance, attractiveness, and worthiness) and psychological (thoughts, feelings, courage, honesty, independence, trust, and aspirations). High and low self-concept owned by someone will affect one's ability to solve problems.

The ability of mathematical connections that are not optimal certainly needs to be improved. How to improve students' mathematical connection skills can be done by using several learning models. One learning model that can be used to improve mathematical connection skills is a problem-based learning model or Problem Based Learning (PBL). Problem-based learning is one of the innovations in learning that is able to optimize students' thinking power through structured and systematic teamwork (Rusman, 2011). PBL uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, as well as to obtain essential knowledge and concepts from the subject matter (Setyorini et al., 2011). The PBL model is based on the idea of collaborative learning in small groups of students who are active and responsible for their own learning processes so that they can build meaningful knowledge by connecting existing knowledge (Maurer & Neuhold, 2012). PBL is considered effective in the process of transforming science and skills to students in the last five decades (Alzughaibi et al., 2016; Kumalasari et al., 2016).

Based on the description above, the purpose of this study is to find patterns of mathematical connection abilities of Grade 8th students in terms of mathematical self-concept.

METHODS

This research is a mixed methods research with a concurrent embedded model. Mixed methods is a research approach that combines quantitative and qualitative research methods (Creswell, 2015). This study unbalances the quality and quantitative methods. Qualitative research is the primary method while quantitative research in this study is nested into a more dominant method. The data used in this study are the data of students' mathematical connection abilities and self-concept data.

The qualitative research design in this study focuses on describing and exploring activities or describing the ability of students' mathematical connections in terms of self-concept with a focus on learning mathematics PBL models. The quantitative research design used in this study uses a quasi-experiment design, which involves two groups, namely the experimental class and the control class. This research was conducted at SMP Negeri 13, Semarang City, Central Java Province, Indonesia.

Qualitative data samples in this study were determined by purposive sampling technique with consideration of each group of self-concept categories which then indicators of each activity were observed based on tests of mathematical connection ability.

The research sample of quantitative data in this study was obtained through random sampling techniques. 2 VIII classes from SMP Negeri 13 Semarang were selected as research samples according to the research design.

The research instrument used was a self-concept questionnaire and a test of students' mathematical connection abilities. Data analysis in qualitative research follows the concept given by Miles & Huberman, namely data reduction, data display, and conclusion drawing/ verification. Qualitative data is collected to expand quantitative process data to deepen understanding (Bragstad et al., 2019). Analysis of quantitative research includes the mathematical connection ability achievement aspects. Quantitative data analysis includes initial data analysis and final data analysis. Initial data analysis includes a normality test, homogeneity test, completeness test, two-party test, and average difference test.

RESULTS AND DISCUSSION

The mathematical connection ability final data descriptive statistics of the experimental and control groups are presented in Table 1 below.

Tabel 1. Descriptive Statistics of Mathematical Connection Abilities Data

Descriptive Statistic	Experiment	Control
Average	80.00	73.81
Variants	76.16	66.40
Standard Deviation	8.73	8.60
Passing Grade	74.29%	60.00%

Based on the mathematical connection abilities data in Table 1 and hypothesis testing to determine the effectiveness of the PBL model, the following results are obtained: The first hypothesis test is related to the average mathematical connection ability of students in the experimental class using PBL learning using the results of the ability test mathematical connection. From the calculation, the value of t_{count} is 6.80 with a significance level of 5% and degree of freedom (*df*) = 34, the t_{table} value is 1.697. Because the value of $t_{count} > t_{(1-\alpha),df}$ then rejects H_0 meaning that the average mathematical connection ability of students in PBL learning has reached an average of more than 70.

The second hypothesis test deals with the classical completeness test of students' mathematical connection abilities in the classroom with PBL Model learning. Testing uses two parties by looking at the Z_{count} value. Based on the calculation results, the Z_{count} value was -0.9972, while the Z_{table} value was 1.96. So the value of Z_{count} is between the value of Z_{table} or $-1.96 < -1.26 < 1.96$ then H_0 is accepted. This means that students' mathematical connection ability in PBL learning with an average of 70 which is equal to 75%.

The third hypothesis test deals with the test of the average difference of students' mathematical connection abilities in the experimental class and the control class. Testing is carried out with the help of SPSS IBM 24.0. The test results show the t_{count} value of 3.067 with a *df* of 68 and a significance level of 5% obtained t_{table} value of 1.995. This shows that the value of $t_{count} > t_{table}$ or 3.067 > 1.995 then H_0 is rejected, meaning that the average mathematical connection ability of students in the experimental class is more than the average value of students' mathematical connection ability in the control class.

Based on the research data analysis, the effectiveness of PBL learning models shows that: (1) the average mathematical connection ability of students reaches more than 70, (2) the classical completeness of the mathematical connection ability of students with PBL learning is equal to 75%, (3) the average mathematical connection ability of students using the PBL model is better than the average mathematical connection ability of students with conventional learning. These three results can be used as indicators of the PBL model on flat side forms learning material in class VIII is effective in improving students' mathematical connection abilities.

Based on the description above, the learning model PBL is effective in improving students' mathematical connection abilities. This is in line with research by Kartikasari & Widjajanti (2017); Padmavathy & Mareesh (2013); Fitriono et al. (2017) which states that PBL is proven effective in increasing students' mathematical connection abilities and teaching mathematics. Learning mathematics by developing connections in mathematics gives better results compared to normal learning in students with low abilities (Ketterlin-Geller et al., 2008). Sugandi & Sumarmo (2010) suggested that PBL provides a significant role in students' mathematical connection abilities achievement whose initial abilities are moderate.

Based on the self-concept classification, it is obtained students grouping data as listed in Table 2 below.

Tabel 2. Student Grouping Data Based on Mathematical Self-Concept

Category	Frequency	Percentage
High	4	11.43
Medium	26	74.28
Low	5	14.29

After classifying mathematical Self-Concepts based on the data in Table 2, then the mathematical connection ability of students based on the self-concept category can each be categorized.

Students' Mathematical Connection Capabilities; High Self-Concept category

Subjects who have mathematical connection abilities that are in the high self-concept category show different results on the Mathematics Connection Ability Test (TKKM), but the results are better than the results of subjects in other self-concept categories. This is proved by the results of the high self-concept subjects' work in Figure 1.

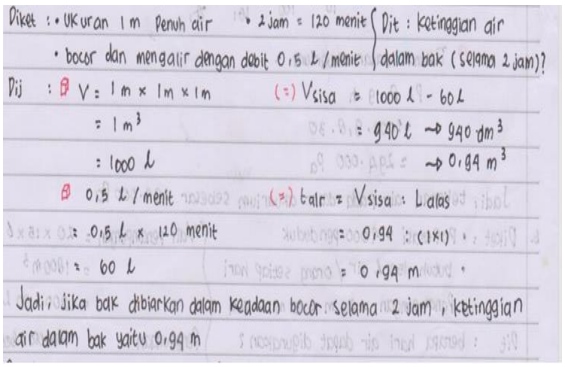

Figure 1. Mathematics Connection Ability Test results from high self-concept category subjects.

In Figure 1, information is obtained that the subject is able to understand the problem well. Subjects write the correct answers with precisely and systematically, which includes the relationship between mathematics and other fields in everyday life with the right and correct completion. Based on the interviews, it is found that subjects with high self-concept can re-explain the mathematical problems well and the correct steps of completion.

In this group, two different patterns of problem solving are found. The patterns are; (1) the first pattern in this category found two subjects able to meet all indicators of mathematical connection ability, in this pattern, the subject understands the problem well and the solution is correct, the subject can connect concepts between topics and the principle of building flat side spaces and model problems to determine the strategy the solution is to find a solution of the problem properly and correctly, (2) the second pattern found two subjects able to meet two indicators of mathematical connection ability.

In this pattern, subjects are not careful in writing mathematical formulas used to solve problems that have an impact on solutions to solving problems. The problem faced by the subjects in this pattern is accuracy. Subjects in this pattern tend to want to work quickly to neglect accuracy in solving problems. In line with this, Panjaitan (2013) suggests that students who neglect accuracy in solving problems tend to answer questions quickly without looking back at the questions information.

Students' Mathematical Connection Capabilities; Medium Self-Concept category

Subjects who have mathematical connection capabilities in the medium category show different Mathematics Connection Ability Test results. In this category, subjects are able to understand the problem well with the correct problem solving solution and the rest do not understand the problem well. This is indicated by the results of the subject's work in Figure 2.

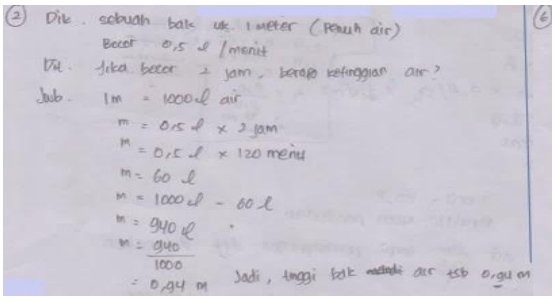

Figure 2. Mathematics Connection Ability Test results from medium self-concept category subjects

As can be seen in Figure 2, the subject is less able to understand the problem given. The subject wrote answers with steps to solve the problem that were not yet acceptable. The subject was only able to calculate the volume of water in the bathtub and convert it into liters and reduce it by the amount of water that came out through the place that was leaking. This means that the subject has only reached the stage of completion of the remaining volume of water during the leak and has not yet calculated the height of the remaining water during the leak. The step forgotten by the subject is to calculate the height of the water in the reservoir by dividing the remaining volume of water by the area of the base of the cube.

Based on the interviews, it is found that subjects with self-concept are not able to parse the problems that are done well even though the completion is correct.

In this group, three different problem solving patterns were found. The pattern is described as follows. (1) the first pattern in this category was found in 4 subjects able to fulfill all indicators of mathematical connection ability. In this pattern, the subject understands the problem well and the correct solution. Subjects can connect concepts between topics and the principle of constructing flat side spaces and modeling problems to determine their solution strategies to find solutions to problems correctly, (2) the second pattern of this self-concept group found 14 subjects were able to fulfill two indicators of mathematical connection ability, namely the relationship of mathematics with other disciplines and mathematics with everyday life. In this pattern, the subject understands the problem well, they can connect the concepts and principles of the flat side material into other subject matter besides mathematics to determine the problem-solving strategy and connect the existing information on the problem into problem-solving to find a solution of the problem properly and right.

The non-fulfillment of the relationship indicators between topics in mathematics is due to a large number of mathematical topics that must be related to problem-solving so that it requires a high range of thinking. Siahaan (2012) in his research results stated that the low achievement of students in connecting between mathematical topics is due to mathematics having relationships in problem-solving so that a broad range of thinking is needed, (3) the third pattern of this group found 8 subjects able to fulfill one indicator of mathematical connection ability namely the relationship of mathematics with everyday life. In this pattern, the subject understands the problem well and has the right solution. The subject is able to connect the concepts and principles of constructing flat side spaces into problem-solving strategies to find solutions to problems well and correctly.

The subjects in this pattern are not able to connect concepts between topics and the principle of flat side materials and modeling problems in determining strategies for solving problems so the problem solutions are wrong. On the relationship of mathematics with other disciplines indicators, the subject cannot understand the problem properly so the strategy in determining problem-solving is not right.

Students' Mathematical Connection Capabilities; Low Self-Concept Category

Subjects in the low self-concept category showed different TKKM results, but none of the subjects in this category met all indicators of mathematical connection ability. In this category, some subjects are able to understand the problem well with correct problem solving solutions and the rest do not understand the problem. This is indicated by the results of the subject's work in Figure 3.

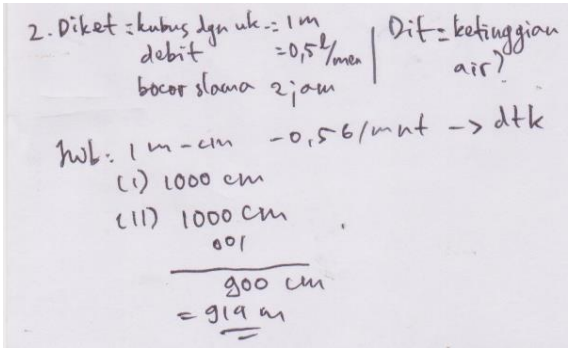

Figure 3. TKKM results of subjects with low self-concept.

Based on Figure 3, it can be seen that the subject does not understand the given problem. The subject did not understand the steps to resolve the problem given. Subjects are only able to write down what they know and ask, but they cannot write the problem-solving steps correctly. Based on the interview results it was found that subjects with low self-concept could not parse the problems that were done with the correct problem solving.

In this group, 5 subjects were found with three different patterns. The pattern is described as follows. (1) the first pattern in this group was found 1 subject able to meet the indicators of the relationship between topics in mathematics. In this pattern, the subject understands the problem well and provides the correct solutions. The subject can connect the concepts between topics and the principle of constructing flat side spaces and modeling problems to determine the solution strategies to find solutions to problems correctly. (2) the second pattern of this group was found 2 subjects were able to meet indicators of the relationship of mathematics with other disciplines and mathematics with everyday life.

In this pattern, the subject understands the problem well, the subject can connect between the concepts and principles of the material to build a flat side space into other subject matter besides mathematics to determine the strategy of problem-solving and connect the existing information on the problem into problem-solving to find solutions to problems with good and right. (3) the third pattern in this group was found 2 subjects were able to meet the indicators of mathematical relationships with daily life. In this pattern, the subject understands the problem well and the correct solution. The subject can connect the concept of flat side space material into other field material to find solutions to problems properly.

The subjects in this pattern cannot connect the relationships between topics and the principle of flat side spaces material and cannot make a mathematical model of the problem so that the problem solving is not correct. In the relationship of mathematics with other disciplines, the subject cannot understand the problem so well so that the strategy in solving the problem is incorrect. While in terms of the mathematical relationships in daily life indicators, subjects in this pattern do not understand the problem well so that problem solving is not right.

CONCLUSION

The mathematical connections ability in terms of self-concept obtained by a variety of patterns. In subjects with high self-concept found two patterns of mathematical connection ability. In subjects with self-concept are found three patterns of mathematical connection ability. In subjects with low self-concept found three patterns of mathematical connection ability.

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