UJME 9 (3) 2020: 199-205
Unnes Journal of Mathematics Education
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

The ability of mathematical representation on problem based learning of Krulik and Rudnick strategies

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ARTICLE INFO

Article history:
Received 17 October 2020
Received in revised form 28 October 2020
Accepted 15 November 2020

Keywords:
Mathematical Representation Ability;
Self-efficacy;
Problem Based Learning;
Krulik and Rudnick Strategy

Abstract

In learning mathematics, students still find it difficult to simplify a problem in the form of a problem description into a picture or symbol of mathematics correctly. This relates to students' mathematical representation ability which is still lacking and also its self efficacy. One effort to improve students' mathematical representation ability is through learning through the PBL model of Krulik and Rudnick's strategies. This study aims to examine the classical completeness of students in the aspects of mathematical representation ability, the average mathematical representation ability of students in the learning model Problem Based Learning of Krulik and Rudnick strategies and Problem Based Learning, and describe the ability of mathematical representation of students based on high self-efficacy, moderate, and low. This research uses a mixed method. The research class was taken by simple random sampling. The subjects of this study were 6 students of class VII A of SMP 1 Jambu who were selected by purposive sampling. Data collection using tests, questionnaires, and interviews. The results showed (1) The ability of mathematical representation with the Problem Based Learning model of the Krulik and Rudnick strategies achieving classical learning completeness; (2) The ability of mathematical representation of students in a class that uses Problem Based Learning Krulik and Rudnick strategies is better than the ability of mathematical representation of students in a class that uses Problem Based Learning; (3) Subjects with high self efficacy are able to meet all indicators of mathematical representation ability although there is still a lack of rigor in the work, subjects with moderate self efficacy are sufficiently able to meet the indicators of mathematical representation ability, while with low self efficacy there are still some indicators that have not yet been achieved namely indicators the ability of students to make mathematical equations or models from other given representations and write the steps for solving and solving mathematical problems correctly.

1. Introduction

Education plays an important role in determining the progress of a country. The education process is closely related to learning. "Learning is a form of activity in which there is a relationship of interaction in the process of learning and teaching between education staff (especially teachers / instructors) and students to develop behavior in accordance with educational goals" (Hamalik, 2011).

In formal education, mathematics becomes one of the subjects that can be used to build students' way of thinking. According to Tarmizi, et al (2010) that effective mathematics learning is the result of complex coordination between certain knowledge and beliefs, as well as the culture of mathematics learning at the school level.

According to NCTM (2000) there are 5 skills that students must possess to learn mathematics, namely (1) Problem solving (2) Reasoning (3) Communication (4) Connection, and (5) Representation. Of the five skills, according to NCTM representation is the center of mathematics learning, because through

To cite this article:
Yulianawati, D. N & Safa'atullah, M. F. (2020). The ability of mathematical representation on problem based learning of Krulik and Rudnick strategies. *Unnes Journal of Mathematics Education*, *9*(3), 199-205. doi: 10.15294/ujme. v9i3.32639

mathematical representation, students can develop and deepen understanding of mathematical concepts and help students communicate their thoughts.

Mathematical representation is a form of interpretation of students' thoughts on a problem, which is used as a tool to find solutions to a mathematical problem (Sabirin, 2014). In line with this statement Kusrianto, et al (2015) revealed that the use of mathematical representations helps students to solve a problem that is considered complex and complex to be simpler if the strategy and utilization of mathematical representations are in accordance with the problem. Based on the two statements, showing that representation is a tool to facilitate students in solving problems.

From the results of interviews with mathematics teachers in grade VII at SMP N 1 Jambu, students' ability in the aspect of mathematical representation has not yet reached maximum results because there are still many students who find it difficult to solve problems in the form of description and change them in the form of symbols or mathematical models. In the aspect of visual representation students also find it difficult to describe and understand the right picture in solving problems.

Another factor that supports success in learning mathematics is the factor of student psychology, one of which is self efficacy. Damaryanti, et al (2017) states that self-efficacy is related to someone's assessment of their ability to complete certain tasks or projects.

Self efficacy is a person's belief in coordinating and directing their ability to change and deal with situations (Nadia, 2017). Through self-efficacy students can encourage their confidence in the ability they have to do a challenge or work. Students with low self efficacy may avoid learning that has many challenging tasks, while students with high self efficacy tend to have great confidence to complete their assignments well

Learning that takes place in class is closely related to the learning model used to provide opportunities for students to develop their abilities. According to Mardiyah, et al (2018) one of the learning models that can improve thinking skills and social interaction between students and teachers on a problem-based basis is the Problem Based Learning (PBL) model.

Mulyono, et al (2019) mentioned problem-based learning can increase student activity in learning, motivation, and student interest in learning. Through the Problem Based Learning model students are grouped in small groups and then work together to provide motivation for ongoing involvement in complex tasks and increase opportunities for joint inquiry and dialogue, and for the development of social skills (Arends, 2013).

In learning, a strategy is needed to support the Problem Based Learning model. One strategy in learning is Krulik and Rudnick's Heuristic strategy. Heuristics is the process of students' activities in thinking not giving a direct answer to a problem. Heuristics are used to help reasoning processes such as asking certain questions, drawing diagrams, looking at problems from different perspectives and others. (Kurniati & Utami, 2013).

According to Krulik and Rudnick interpreting the heuristic strategy in the five steps of learning which came to be known as the KR heuristic model including (1) Reading (2) Exploration (3) Select a strategy (4) Solve (5) Review. (Carson, 2007). Through learning strategies Krulik and Rudnick can foster curiosity and creative attitudes in students. (Hamdiah & Fajar, 2012).

Based on the initial explanation, there are several problem formulations in this study, which are as follows (1) whether the mathematical representation ability of grade VII students with Problem Based Learning Krulik and Rudnick's strategies achieve classical completeness? (2) Is the average mathematical representation ability of students with Problem Based Learning Krulik and Rudnick strategies better than the average mathematical representation ability of students with Problem Based Learning? (3) What is the description of students' mathematical representation abilities based on self-efficacy in learning Problem Based Learning Krulik and Rudnick strategies ?.

The purpose of this study is as follows (1) to find out whether the mathematical representation ability of students with the Problem Based Learning strategy Krulik and Rudnick achieve classical completeness (2) to find out whether the average mathematical representation ability of students with Problem Based Learning Krulik and Rudnick strategies is better of the average mathematical representation ability of students with Problem Based Learning (3) to describe the ability of mathematical representation of students based on self-efficacy in learning Problem Based Learning Krulik and Rudnick strategies.

The hypotheses proposed in this study are as follows (1) the ability of mathematical representation of students with Problem Based Learning Krulik and Rudnick strategies achieve classical completeness (2) the average mathematical representation ability of students in the class being taught by using Problem Based Learning Krulik and Rudnick strategies better than the mathematical representation ability of students taught by using Problem Based Learning.

2. Methods

This type of research used in this study is a combination research method. As for the research design used in this study is a sequential explanatory design, which is a research design that combines quantitative methods and qualitative methods by collecting quantitative data first then proceed with collecting qualitative data (Creswell, 2014: 299). Quantitative methods are used to find out whether students' mathematical representation abilities with the Problem Based Learning strategy Krulik and Rudnick achieve classical completeness and find out whether the average mathematical representation ability of students with Problem Based Learning Krulik and Rudnick strategies is better than the average mathematical representation ability of students with Problem Based Learning in class VII students of SMP Negeri 1 Jambu. While the qualitative method is used to determine the ability of mathematical representation based on students' self efficacy in learning the Problem Based Learning model of Krulik and Rudnick's strategies.

The population used in this study were all grade VII students of SMP Negeri 1 Jambu in the even semester of the 2018/2019 academic year, namely classes VIII A - VIII F. The technique used in sampling in this study was simple random sampling. Simple random sampling is done by randomly selecting two classes from the population without strata differences between each class (Sugiyono, 2016). In this study class VII A was taken as an experimental class by being given treatment in the form of learning through the Problem Based model Krulik and Rudnick learning strategies and class VII C as a control class that is given treatment in the form of mathematics learning through the Problem Based Learning model. Determination of the subjects in this study used a purposive sampling technique, namely by selecting two research subjects from each student with a high classification of self-efficacy, moderate self-efficacy, and low self-efficacy.

The independent variables in this study are the Problem Based Learning model with Krulik and Rudnick strategies and the Problem Based Learning model. While the dependent variable in this study is the ability of mathematical representation based on the self efficacy of SMP Negeri 1 Jambu students. Data collection methods used in this study are (1) documentation method used to obtain data related to research; (2) the test delivery method used to obtain students' mathematical representation ability data; (3) the method of giving questionnaires in this study was used to obtain data on students' self efficacy; (4) and the interview method used to obtain in-depth information about mathematical representation capabilities in the form of student self-efficacy based on the tests provided. In this study the questionnaire used adopted from the questionnaire that was created and tested previously by Tunjungsari (2018).

Quantitative data analysis techniques are used to test whether students' mathematical representation abilities with the Problem Based Learning strategy of Krulik and Rudnick achieve classical completeness and test whether the average mathematical representation ability of students with the Problem Based Learning of Krulik and Rudnick's strategies is better than the average mathematical representation ability students with Problem Based Learning in class VII students of SMP Negeri 1 Jambu. While qualitative data analysis techniques are used to obtain a description of students 'mathematical representation abilities based on students' self efficacy in learning the Problem Based Learning model of Krulik and Rudnick's strategies. This qualitative data was obtained through interviews with six research subjects in the experimental class. Of the six subjects, two subjects were students with high self efficacy, two subjects with moderate self efficacy, and two subjects with low self efficacy.

3. Results & Discussions

3.1. Completeness Test of Mathematical Representation Ability

The results of this mathematical representation ability test are used for the final data analysis. Data on the mathematical representation ability of students from the two research classes is presented as follows.

Table 1. Data value of mathematical representation ability

Class	N	Σ	Standard	Max	Min
Experiment Class	32	79,30	7,51	95,83	64,58
Control Class	32	75,05	8,19	87,5	60,42

Before testing the hypothesis, a normality test and a homogeneity test are performed first. Based on calculations using SPSS 16.0 software, it is obtained $Sig. = 0.060$. Clearly $Sig. = 0.060 > 0.05$ so H_0 is accepted. This means that the data of the mathematical representation ability test values come from normally distributed populations. Based on this, for further analysis and calculation in this study using parametric statistics. This is in line with the opinion of Sugiyono (2016: 210) which states that the use of parametric statistics requires the fulfillment of many assumptions, and the main assumption is that the data to be analyzed must be normally distributed.

After the normality test, then proceed with the homogeneity test Based on calculations with the help of SPSS 16.0 software, Sig. Homogeneity test is $Sig. = 0.469$. Obviously $Sig. = 0.469 > 0.05$, so H_0 is accepted, which means that the data on the mathematical representation ability test has the same or homogeneous variance. Based on the homogeneity test, the results show that the mathematical representation ability of the experimental class and the control class have the same variance.

Then the hypothesis test is performed which includes a mean test, a one-party proportion test, and a difference test of two averages. The average test is used to determine whether the average mathematical representation ability of students in the experimental class reaches individual completeness. Based on the results of calculations with ms.excel, it was found that $t_{count} = 3.27$ and t_{count} with a probability of 0.95, obtained $t_{table} = 1.69$. Because $t_{count} = 3.27 > t_{table} = 1.69$, H_0 is rejected. In conclusion, the average students' mathematical representational ability test is more than 75, so that they are declared individually.

Furthermore, the one-party proportion test is used to determine whether the average mathematical representation ability of students in the experimental class achieves individual completeness of 75 and reaches classical completeness of 75%. Based on the results of calculations using ms.excel, it was found that $z_{count} = 2.04$ and $z_{table}$with a significance level of 0.05 and probability $= (0.5 - 0.05) = 0.45$, obtained $z_{table} = 1.64$. Because $z_{count} = 2.04 > z_{table} = 1.64$, H_0 is rejected. In conclusion, the test results of students' mathematical representation ability by learning the PBL model of the Krulik and Rudnick strategies achieve classical completeness. Based on the average test results and the one-party proportion test it can be said that the experimental class achieved mastery learning. This refers to the opinion of Masrukan (2014) which states that the criteria for mastery learning include individual completion and classical completion.

As for the two difference test the average is used to test the average mathematical representation ability in the experimental class is higher than the average mathematical problem solving ability in the control class. Based on the results of calculations using ms.excel, it was found that that $t_{count} = 1.97$ and that t_{table} with a degree of trust $(\alpha) = 0.05$, obtained $t_{table} = 1.669$. Because $t_{count} = 1.97 = 2.669 > t_{table} = 1.668271$, H_0 is rejected. In conclusion, students 'mathematical representation ability by learning the PBL model Krulik and Rudnick's strategy is more than students' mathematical representation ability by learning PBL models.

This is supported by research results from Dika Handayani (2016) showing that learning outcomes in the aspect of mathematical representation ability in the PBL model achieve classical completeness. . In addition, the Krulik and Rudnick strategies make students more structured and able to solve problems systematically in accordance with Krulik and Rudnick's step by step problem solving. This is in line with the opinion expressed by Hamdiah & Fajar (2012) which states that the Krulik and Rudnick strategies help students in solving problems, making analysis and synthesis, as well as evaluating the results of problem solving.

3.2. Mathematical Representation Ability Based on High Self Efficacy

Based on the results of the analysis it can be seen that subjects who have high self efficacy are able to fulfill three indicators of mathematical representation ability, namely the ability of students to make equations or mathematical models from other representations given, the ability of students to draw geometrical shapes to clarify problems and facilitate resolution and write steps step resolution and solve mathematical problems with words. Based on the results of the study, obtained information that students with high self-efficacy can write mathematical models and equations of rectangular and square problems correctly. In addition, high self-efficacy students can express mathematical ideas in the form of pictures completely, and can write steps and solve mathematical problems completely and accurately. Thus, students with high self efficacy have no difficulty in completing and expressing abstract ideas in the form of mathematical representations. This is consistent with what was said by Bandura (1997), that individuals with high self-efficacy can solve problems with persistence and correctness.

3.3. Mathematical Representation Ability Based on Moderate Self Efficacy

Based on the results of the analysis it can be seen that subjects who have moderate self-efficacy are able to meet the indicators of mathematical representation ability. Sufficiently capable here means that of the three indicators of mathematical representation ability, subjects with moderate self-efficacy are only able to fulfill two indicators of mathematical representation ability. Where in this case the subject with self efficacy is having different characteristics. One subject of self efficacy is being able to meet the indicators of the ability of students to make equations or mathematical models from other representations given and the ability of students to make geometric figures to clarify problems and facilitate resolution. geometry to clarify the problem and facilitate the solution and write down the steps of the solution and solve the mathematical problem with words. Based on the results of the study, obtained information that students with moderate self-efficacy can meet the indicators of mathematical representation ability well. Often students with self efficacy are making a few mistakes, which are not careful in doing calculations or in writing one in the completion and not giving information in the picture. From the results of the mathematical representation ability test results obtained data that most of the students in the class including moderate self efficacy classification.

3.4. Mathematical Representation Ability Based on Low Self Efficacy

Based on the results of the analysis it can be seen that subjects who have low self efficacy are only able to fulfill one indicator of the ability of mathematical representation, namely the ability of students to make geometrical shapes to clarify problems and facilitate resolution. Based on the results of the study, obtained information that students with low self-efficacy are less able to write mathematical models and equations of rectangular and square problems correctly. In some cases they only write what is known and asked without writing a mathematical model. In addition, low self-efficacy students can express mathematical ideas in the form of drawings correctly but they are incomplete because they only draw geometrical figures without being accompanied by an explanation of the size of the image. The subject of low self efficacy is less able to write down steps and solve mathematical problems completely and precisely. In some numbers their questions are incomplete in writing the steps to solve the problem and are still wrong in doing calculations. When learning in class, students with low self efficacy do not dare to ask the teacher if there is material that is not yet understood so that they are not biased working on the questions given by the teacher. This is in accordance with what Bandura (1997) said, that students with low levels of self efficacy still doubt their abilities so that there are still students who do not understand the material concept because they feel they do not understand or are unable.

4. Conclusion

Based on the analysis and discussion, it can be concluded that (1) The ability of mathematical representation with the Problem Based Learning model of the Krulik and Rudnick strategies reaches the mastery of classical learning (2) The ability of mathematical representation of students in classes using the Problem Based Learning of Krulik and Rudnick strategies is better than the ability of mathematical representation students in classes using the Problem Based Learning model. (3) The ability of mathematical representation of high self-efficacy subject is able to fulfill all indicators of mathematical representation ability, namely the ability of students to make equations or mathematical models from other given representations, the ability of students to draw geometrical shapes to clarify problems and facilitate resolution and write steps for completion and solve mathematical problems with words. The ability of mathematical representation of subjects is self efficacy while cukuo is able to meet the indicators of mathematical representation ability. Enough is able to be interpreted here from the three indicators of mathematical representation ability of subjects with low self efficacy only able to meet two indicators of mathematical representation ability. Where in this case the subject with self efficacy is having different characteristics. One subject of self efficacy is able to meet indicators 1 and 2, while the other subject is able to meet indicators 2 and 3 of the indicators of mathematical representation ability. The ability of mathematical representation of subjects as low as self-efficacy is less able to meet the indicators of mathematical representation ability. Inadequacy here means that subjects with low self-efficacy are only able to meet one indicator, namely the ability of students to create geometric figures to clarify and facilitate completion.

References

Arends, R. (2013). *Belajar untuk Mengajar "Learning to Teach, Ninth Edition"*. Jakarta: Salemba Humanika.

Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. New York: W.H. Freeman and Company.

Carson, J. (2007). A Problem With Problem Solving Teaching Thinking Without Teaching Knowladge. *The Mathematics Educator*, 17(2): 7-14.

Creswell, J. (2014). *Research Design Pendekatan Metode Kualitatif, Kuantitatif, dan Campuran*. Yogyakarta: Pustaka Pelajar.

Damaryanti, D. D., Mariani, S., & Mulyono. (2017). The Analysis of Geometrical Reasoning Ability Viewed from Self-Efficacy on Connected Mathematic Project (CMP) Learning Etnomathematics-Based. *Unnes Journal of Mathematics Education*, 6(3): 325–332.

Hamalik, O. (2011). *Kurikulum dan Pembelajaran*. Jakarta: Bumi Aksara.

Hamdiah, E., & Fajar, R. (2012). *Teori-Teori Pembelajaran*. Yogyakarta: Pustaka Pelajar.

Kurniati, L., & Utami, B.M. (2013). Pengaruh Metode Penemuan Strategi Heuristik Terhadap Kemampuan Berpikir Kritis Matematis. *Himpunan Matematika Indonesia.* 209.

Kusrianto, S.I., Suhito, & Wuryanto. (2016). Keefektifan Model Pembelajaran CORE Berbantuan Pop Up Book Terhadap Kemampuan Siswa Kelas VIII Pada Aspek Representasi Matematis. *Unnes Journal of Mathematics Education*, 5(2): 155-162.

Mareta, D. R., Yeni, & Kusumawati D. (2014). Pendekatan Hands On Activity Melalui Modified Inquiry Untuk Meningkatkan Self Efficacy Siswa Kelas XI SMA N 1 Tuban Pada Materi Pokok Laju Reaksi. *Unesa Journal of Chemical Education*, 3(1): 70-75.

Mardiyah, I., Suhito & Safaatullah, M. F. (2018). Analysis of Mathematical ReasoningAbility of Junior High School Students of Grade VII Viewed From Cognitive Style On Problem Based Learning With Mind Mapping. *Unnes Jounal of Mathematics Education*, 7(2): 122-128.

Masrukan. (2014). *Asesmen Otentik Pembelajaran Matematika Mencangkup Asesmen Afektif dan Karakter*. Semarang: Universitas Negeri Semarang.

Mogapi, M., Moalosi, W.T.S., & Tsheko, G. N. (2017). "Self-Efficacy Factor Invariance Across Pre-Service and In-Service Teachers in Botswana". *Asian Research Journal of Arts & Social Sciences*, 4(4): 1-10.

Mulyono, Rahmawati, M. I., & Amidi. (2019). The Ability of Mathematical Problrm Solving Reviewed From Goal Orientation to Lerning Model of Problem Based Learning Asisted by Probem Card. *Unnes Jounal of Mathematics Education,* 8(1): 8-13.

Nadia, L. N., Waluyo, ST. B., Isnarto. (2017). Analisis Kemampuan Representasi Matematis Ditinjau dari Self Efficacy Siswa melalui Inductive Discovery Learning. *Unnes Jounal of Mathematics Education Research*, 6 (2): 242-250.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. Reston : The National Council of Teachers of Mathematics, Inc.

Ramziah, S. (2016). Peningkatan Kemampuan Representasi Matematis Siswa Kelas X_2 SMAN 1 Gedung Meneng Menggunakan Bahan Ajar Matriks Berbasis Pendekatan Saintifik. *Jurnal Mosharafa*, 5 (2): 138-147.

Sabirin, M. (2014). Representasi dalam Pembelajaran Matematika. *Jurnal Pendidikan Matematika IAIN Antasari*, 2: 33-44.

Saputro, D. A., Masrukan, & Agoestanto, A. (2017). Mathematical Communication Ability by Grade VII Students Using a Themed Problem Based Learning with Scaffolding on Rectangle Materials. *Unnes Jounal of Mathematics Education*, 6 (2): 239-248.

Sudjana, N. (2009). *Penilaian Hasil Proses Belajar Mengajar*. Bandung: PT Remaja Rosdakarya Offset.

Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif, dan Kombinasi (Mix Methods)*. Bandung: Alfabeta.

Tarmizi, M. A. A., Tarmizi, R. A., & Mokhtar, M. Z. B. (2010). Humanizing mathematics learning: Secondary students beliefs on mathematics teachers' teaching efficacy. *Procedia-Social and Behavioral Sciences*, 8: 532-536.