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Analysis of the mathematical representation ability of class VIII students in terms of self-regulated learning with the inductive discovery learning model

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Abstract

The aim of this study was to determine the mathematical representation ability of class VIII students in terms of self-regulated learning with the Inductive Discovery Learning Model. This type of research is a mix methods research with a concurrent embedded design (unbalanced mix). The population in this study were class VIII students of Semarang 40th State Junior High School in the academic year 2020/2021. The data collection technique used triangulation, comparing the data obtained from interviews, observations, and final tests of mathematical representation abilities. The research subjects selected were 6 students, consisting of 2 students with high self-regulated learning, 2 students with medium self-regulated learning, and 2 students with low self-regulated learning. The results of the study indicate that students with high self-regulated learning have high mathematical representation abilities, students with medium self-regulated learning have medium mathematical representation abilities, and students with low self-regulated learning have low mathematical representation abilities.

1. Introduction

Peraturan Menteri Pendidikan dan Kebudayaan Number 22 of 2006 concerning content standards for primary and secondary education units explains that mathematics is aimed at enabling students to have the following abilities: (1) understands mathematical concepts, explain the interrelationships between concepts and apply concepts or algorithms flexibly, accurately, and precise in solving problems, (2) using reasoning on patterns and properties, performing mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements, (3) solving problems which include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained, (4) communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem, and (5) have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, and interest in learn mathematics, as well as tenacious and trusting attitude themselves in problem solving.

This is similar to as it was formulated by (NCTM, 2000: 7) related to the learning process that emphasizes on five standards processes, namely problem solving, reason and proof, communication, connections, and representation. Indicate to (Brenner: 2009) states that successful problem-solving process, depends on problem presenting skills such as constructing and using mathematical representations in words, graphs, tables, equations, solving, and manipulating symbols. Thus, good mathematical representation skills are needed so that the problem solving process in mathematics is successful.

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Semarang 40th State Junior High School is a junior high school that uses the 2013 curriculum (K-13). However, the facts in the field are that the VIII grade mathematics teacher of Semarang 40th State Junior High School did not fully implement the 2013 curriculum in a scientific approach. When the learning process takes place, it was seen that the attitude of students who were enjoy themselves with their classmates, less attention to the teacher, did not take the initiative to read and do the problem if the teacher did not tell them to, so that the attitude of self-regulated learning of students at Semarang 40th State Junior High School was still lacking. In addition, the mathematical representation of students is also still lacking because they are still not able to write answers that are in accordance with mathematical steps.

Based on the results of the pre-tests of students related to mathematical representation skills, the average pre-test of students in class VIII A of Semarang 40th State Junior High School is 62,07 of 29 students who take the pre-tests. The Actual Completeness Limit for the mathematical representation ability of students at Semarang 40th State Junior High School is 65. Based on the results of students' pre-test, it was seen that students have not been able to understand the questions given. This is indicated by students not being able to interpret problems in the form of mathematical expressions correctly so that the mathematical steps become less precise.

The success of students' learning in mathematical representation abilities is influenced by various factors, one of which is self-regulated learning. Indicate reference by (Sugandi, 2013) states that self-regulated learning is an attitude that has the characteristics of taking the initiative to learn, diagnosing learning needs, setting learning goals, monitoring, regulating and controlling performance or learning to view difficulties as challenges, seeking and utilizing relevant learning resources, selecting and implementing learning strategies, evaluate the process and learning outcomes, as well as self-concept.

Based these facts obtained an alternative learning strategy in an effort to develop students' mathematical representation skills in this study is the Inductive Discovery Learning model. The components in the discovery process include observing, classifying, predicting, measuring, explaining, and concluding. Weimer identified 6 types of discovery learning, one of which is Inductive Discovery Learning. Indicate references by (Yang, 2010: 1-2) explain that Inductive Discovery Learning is learning where discovery learning is a pedagogic strategy that reduces direct teacher instruction and builds students' own knowledge. Students can learn mathematical concepts better when they are involved in the induction process, namely observing several examples of concepts, looking for and trying examples, and generalizing their findings with the right written word, thus enabling students to form different conceptual structures that are appropriate to summarize their findings.

Each student has a different way of dealing with the problems they face and building their knowledge. Through Inductive Discovery Learning, it emphasizes that students learn mathematics about mathematical concepts and structures contained in the material being studied, as well as looking for relationships between mathematical concepts and structures. This allows students to develop self-regulated learning so that is has a good effect on their mathematical representation abilities.

The purpose of this study was determine (1) the mathematical representation ability of class VIII students with the Inductive Discovery Learning model can achieve classical completeness, (2) the mathematical representation ability of class VIII students with the Inductive Discovery Learning model is better than Problem Based Learning model, (3) there are any influence of self-regulated learning on the mathematical representation ability of class VIII students with Inductive Discovery Learning model and, (4) the mathematical representation ability of class VIII students in terms of self-regulated learning with the Inductive Discovery Learning.

2. Methods

This research was conducted in class VIII of Semarang 40th State Junior High School in the 2020/2021 academic year. The research method used in this research is mix methods research with a concurrent embedded design (unbalanced mix). Indicated references by (Sugiono, 2013: 537) states that concurrent embedded design mix methods research is a method of mix methods between quantitative and qualitative research methods by mixing the two methods unbalanced. The quantitative method in this study was carried out to measure the classical completeness of students' mathematical representation abilities in Inductive Discovery Learning model, compare students' mathematical representation abilities in Inductive Discovery Learning and Problem Based Learning models, and measure whether there is an influence of self-regulated learning on the mathematical representation ability with the Inductive Discovery Learning model. While the qualitative method is carried out to analyse the results of students' mathematical representation abilities with the Inductive Discovery Learning model in terms of self-regulated learning.

Sampling in this study using simple random sampling technique so that the sample obtained in this study is class VIII A as the experimental class using the Inductive Discovery Learning model and class VIII B as the control class using Problem Based Learning model. While taking research subjects to be interviewed using purposive sampling technique by grouping self-regulated learning into three groups, namely high self-regulated learning, medium self-regulated learning, and low self-regulated learning. The grouping carried out based on the acquisition of students' self-regulated learning questionnaire scores using the standard deviation method.

The data collection methods in this study were: (1) observations were made to observe mathematical representation abilities, (2) questionnaires were used to collect self-regulated learning data, (3) tests were in the form description tests and were carried out after students received learning with Inductive Discovery Learning model, and (4) interviews were conducted to determine the description of students' mathematical representation abilities in terms of self-regulated learning.

The data validity test in this study was carried out using triangulation technique, namely comparing the data from the mathematical representation ability test results, results of interviews and results of observations. Data analysis is done by data reduction, data display, and verifications.

3. Results and Discussions

3.1 Analysis Quantitative Methods

The data analysis was carried out on the data from the results of the test of mathematical representation abilities. Then, data analysis was carried out which included normality test, homogeneity test, average test, completeness test, difference test of two-average, difference test of two-proportion, and influence test. The statistical results of the experimental class and control class students are presented in the following table.

Table 3.1 The Statistical Results of the Mathematical Representation Ability Test

No	VIII A (Experimental Class)	VIII B (Control Class)
$\sum f$	32	32
$\bar{x}$	77.60	71.15
s	8.754	9.667

Table 3.1 The Statistical Results of the Students Self-Regulated Learning Questionnaire in the Experimental Class

No	VIII A (Experimental Class)
$\sum f$	32
$\bar{x}$	57.72
s	7.74

Based on the results of quantitative data analysis from the test of mathematical representation ability the data of the two samples were normally distributed and had the same variance (homogeneous) so that the data of the two samples could be used.

The average test obtained is $t_{count} = 4{,}914 > t_{table} = 1{,}695$, then H_0 is rejected and H_1 is accepted. So it can be concluded that the average mathematical representation ability of students with Inductive Discovery Learning model reaches more than KKM, which is 70. While the completeness test is carried out using the proportion test so that it is obtained $Z_{count} = 1{,}687 > Z_{table} = 1{,}645$, then H_0 is rejected and H_1 is accepted. So it can be concluded that the mathematical representation ability of class VIII students with the Inductive Discovery Learning model reaches more than the classical KKM.

The difference test of two averages obtained is $t_{count} = 2{,}778 > t_{table} = 1{,}670$, then H_0 is rejected and H_1 is accepted. So it can be concluded that the average mathematical representation ability class VIII students with the Inductive Discovery Learning model is better than Problem Based Learning model. While the difference test of two proportions obtained is $z_{count} = 2{,}869 > z_{table} = 1{,}645$, then H_0 is rejected and H_1 is accepted. So it can be concluded that the proportion of mathematical representation abilities of class VIII students who complete learning using the Inductive Discovery Learning model is better than Problem Based Learning model.

The effect test was carried out using linear regression analysis which included regression equations, regression linearity test, regression coefficient significance test, and simple correlation coefficient test. The regression equation obtained is $\hat{Y} = 47{,}617 + 0.520X$. The test to the linearity of the regression obtained is that regression equation obtained is $F_{count} = 1{,}48 < F_{table} = 2{,}37$, then H_0 is accepted, so it is a linear regression. The significance test of the regressions is coefficient obtained is $F_{count} = 8{,}45 > F_{table} = 4{,}17$, then H_0 is rejected and H_1 is accepted, so linear regression means. The simple correlation coefficient test obtained $t_{count} = 3{,}293 > t_{table} = 2{,}042$, then H_0 is rejected and H_1 is accepted, so the simple correlation coefficient means. Based on the results of the influence test, it can be concluded that there is an influence between students' self regulated learning and mathematical representation abilities.

Meanwhile, based on the results of calculations using a regression test consisting of a linearity test, a significance test, and a simple correlation coefficient test, it shows that there is an influence of students' self-regulated learning on the mathematical representation ability with the Inductive Discovery Learning model. In the simple regression analysis between the self-regulated learning variable and the mathematical representation ability variable, which is 22%. Research by (Sigia, 2020) states that the influence of learning models on mathematical representation abilities depends on the self-regulated learning of students or vice versa.

3.2 Analysis of Qualitative Methods

Qualitative data were obtained from this study based on the results of tests of mathematical representation abilities, observations, and the results of interviews conducted by researchers with the research subjects. In this section, the achievement for categories high, medium, and low self-regulated learning will be shown. Subjects selected based on consideration are research subjects E-02 and E-14 with high self-regulated learning category, research subjects E-08 and E-12 with medium self-regulated learning category, and research subjects E-07 and E-15 with low self-regulated learning category.

3.2.1 Mathematical Representation Ability with High Self-Regulated Learning Category

The research subjects interviewed for the mathematical representation ability with high self-regulated learning category were research subjects E-02 and E-14. Based on the results of mathematical representation ability test, it shows that research subjects with high self-regulated learning category can achieve mathematical representation well.

This proven because the research subjects E-02 and E-14 can achieve 3 indicators of mathematical representation in the question given. Even though in question number 5 the research subject E-14 lacked time to solve the problem so that the verbal representation indicator in question number 5 could not be met by the research subject E-14. Therefore, in general, it can be concluded that the research subject E-14 is able to master the three indicators of mathematical representation. While the research subject E-02 did not experience the slightest obstacle in fulfilling the three indicators of mathematical representation in the question given.

On the visual representation indicators for questions number 1 and 4. Research subject E-02 is able to draw graphs according to what is known and provide information in the form of coordinate points to clarify the graph. While the research subject E-14 is also able to draw graphs according what is known and provide information in the form of coordinate points to clarify the graph. From the results of this analysis, it can be concluded that the mathematical representation ability of research subject with high self-regulated learning categories on visual representation indicators is included in good criteria because they are able to understand and draw graphs according to what is known correctly

On the symbolic representation indicators for questions number 2, 3, 4, and 5. Research subjects E-02 is able to convert every existing problem into a mathematical model correctly and also solve the problems using mathematical expressions appropriately. While the research subject E-14 is also able to convert every problem into a mathematical model correctly and solve the problems using mathematical expressions appropriately. From the results of analysis, it can be concluded that the mathematical representation ability of research subjects with high self-regulated learning categories on symbolic representation indicators is included in good criteria because they are able to convert problems into mathematical models and use mathematical expressions appropriately to solve problem.

On the verbal representation indicators for question number 1, 2, 3, 4, and 5. Research subject E-02 was able to write down each completion step in complete and correct words and was able to write the conclusions from each question. However, in question number 5, the research subject E-02 looks less precise in the calculations. While the research subject E-14 was also able to write down the completion steps in complete and correct words and be able to write down the conclusions of each question. However, on question number 5, the research subject E-14 was not done because there was lack of time to solve the problem. From the results of the analysis, it can be concluded that the mathematical representation ability of research subjects with the high self-regulated learning categories on verbal representation indicator is included in good criteria because they are able to understand and write completion steps in complete and correct words even though there are any question that are not done.

3.2.2 Mathematical Representation Ability with Medium Self-Regulated Learning Category

The research subjects who were interviewed for the mathematical representation ability with medium self-regulated learning were research subjects E08 and E-12. Based on the results of the mathematical representation ability test, it shows that the research subject with medium self-regulated learning has a fairly good mathematical representation.

This is proven because the research subjects E-08 and E-12 can meet the indicators of visual representation and symbolic representation in using mathematical expressions well, but are quite capable of fulfilling the symbolic representation indicators in making mathematical models and are still less than optimal in fulfilling verbal representation indicators.

On the visual representation indicators for question number 1 and 4. Research subject E-08 is able to draw graphs according to what is known and provide information in the form of coordinate points to clarify the graph. While the research subject E-12 is also able to draw graphs according to what is known and provide information in the form of coordinate points to clarify the graph. However, on question number 4 the research subject E-12 did not draw the graph because there was a lack of time to solve the problem. From the results of the analysis, it can be concluded that the mathematical representation ability of research subject with medium self-regulated learning categories on the visual representation indicators is included in good criteria because they are able to understand and draw graphs according to what is known correctly even though there are any question that are not done.

On the symbolic representation indicators for question number 2, 3, 4, and 5. Research subject E-08 is able to convert every existing problem into a mathematical model correctly and also solve problems using mathematical expressions correctly. However, on question number 5 the research subject E-08 was not done because unable to understand the existing problem and a lack of time to solve the problem. Meanwhile, the research subject E-12 is also able to convert every existing problem into a model mathematical correctly and solve problems using mathematical expressions correctly. However, on question number 5 the research subject E-12 did not understand the existing problems so that the mathematical model that had been made was incorrect. From the results of the analysis, it can be concluded that the mathematical representation ability of research subject with medium self-regulated learning categories on symbolic representation indicators is included in quite well criteria because they are quite capable of converting problems into mathematical models and using mathematical expressions appropriately to solve problems.

On verbal representation indicators for questions number 1, 2, 3, 4, and 5. Research subject E-08 is able to write conclusions on each completion and write down the completion steps in complete and correct words except number 3 and 4 are still incomplete. However, on question number 5 the research subject E-08 was not done because unable to understand the existing problem and a lack of time to solve the problem. Meanwhile the research subject E-12 is also able to write conclusions on each completion and write the completion steps in complete and correct words except number 4 is still incomplete in writing the completion steps and less through in calculations. While on question number 5, the research subject E-12 was not done because unable to understand the existing problem and lack of time to solve the problem.

From the results of the analysis, it can be concluded that the mathematical representation ability of research subject with medium self-regulated learning categories on the verbal representation indicators is included in the poor criteria because it is still not optimal in writing the completion steps in words.

3.2.3 Mathematical Representation Ability with Low Self-Regulated Learning Category

Research subjects interviewed for mathematical representation ability with low self-regulated learning categories were research subjects E-07 and E-15. Based on the results of the mathematical representation ability test, it shows that research subjects with low self-regulated learning categories have poor mathematical representation.

This is proven because the research subjects E-07 and E-15 can meet the visual representation and symbolic representation indicators in making mathematical models well, but have little difficulty in fulfilling the symbolic representation indicators in using mathematical expressions and are unable to meet the verbal representation indicators.

On the visual representation indicators for question number 1 and 4. Research subject E-07 is able to draw graphs according to what is known and provide information in the form of coordinate points to clarify the graph. However, on question number 4 the research subject E-07 did not draw the graph because there was a lack of time to solve the problem. While the research subject E-15 is also able to draw graphs according to what is known and provide information in the form of coordinate points to clarify the graph. However, on question number 4 the research subject E-15 did not draw the graph because there was a lack of time to solve the problem. From the results of the analysis, it can be concluded that the mathematical representation ability of research subject with low self-regulated learning on visual representation indicators is included in good criteria because they are able to understand and draw graphs according to what is known correctly even though there are any question that are not done.

On the symbolic representation indicators for question number 2, 3, 4, and 5. Research subject E-07 was able to concert every existing problem into a mathematical model correctly and do not write down the mathematical expressions used to solve the problem so that it goes directly to the solver. However, on question number 5 the research subject E-07 was not done because unable to understand the existing problem and lack of time to solve the problem. Meanwhile, the research subject E-15 was also able to convert every existing problem into a mathematical model correctly and solve problem using mathematical expressions correctly but still not through in calculations. However, on question number 5 the research subject E-15 was not done because unable to understand the existing problem and lack of time to solve the problem. From the results of the analysis, it can be concluded that the mathematical representation ability of research subjects with low self-regulated learning categories on symbolic representation indicators is included in quite well criteria because they are quite capable of converting problems into mathematical models and using mathematical expressions appropriately to solve problems even though there are any question that are not done.

On the verbal representation indicators for questions number 1, 2, 3, 4, and 5. Research subject E-07 did not write down the completion steps in words but wrote the conclusion of each completion. However, on question number 5 the research subject E-07 was not done because unable to understand the existing problem and lack of time to solve the problem. While the research subject E-15 was less than optimal in writing the completion steps in words and did not write down the conclusions of each completion. However, on question number 5 the research subject E-15 was not done because unable to understand the existing problem and lack of time to solve the problem. From the results of the analysis, it can be concluded that the mathematical representation ability of research subjects with low self-regulated learning categories on verbal representation indicators is included in bad criteria because they are not optimal in writing completion steps in words.

4. Conclusion

Based on the description above, it can be concluded that: (1) the mathematical representation ability of class VIII students with the Inductive Discovery Learning model can achieve classical completeness, (2) the mathematical representation ability students with Inductive Discovery Learning model is better than Problem Based Learning model, (3) there is an influence of students' self-regulated learning on the mathematical representation ability with the Inductive Discovery Learning model of 22%, (4) students with high self-regulated have better representational abilities than medium or low self-regulated, because they are able to meet the indicators visual representation, symbolic representation, and verbal representation, students with medium self-regulated have good representation abilities in fulfilling visual representation and symbolic representation but still not maximal in verbal representation, students with low self-regulated have good mathematical representation abilities in fulfilling visual representation, but quite good in symbolic representation and not good in verbal representation.

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