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Mathematical Literacy Ability Reviewed from Cognitive Style of Students on Double Loop Problem Solving Model with RME Approach

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Abstract

Mathematical literacy ability and students cognitive styles play important role in mathematics learning. The purpose of this study was to know the quality of learning and mathematical literacy ability reviewed from the students' cognitive style in learning by using Double Loop Problem Solving model with the RME approach. This study conducted on VIII grade students of SMP Negeri 40 Semarang in the academic year of 2017/ 2018. This study applied a mixed method with concurrent embedded designs. The results of the study showed that learning by using Double Loop Problem Solving model with RME approach on students' mathematics literacy abilities is good qualified. Students with reflective cognitive style were able to master communication, mathematizing, reasoning and argumentation, and devising strategies for solving problems very well, the components of representation, using symbolic, formal, and technical language and operation, and using mathematics tools were quite well mastered. Students with impulsive cognitive style were able to master communication very well, the components of mathematizing, reasoning and argumentation, representation, devising strategies for solving problems, using symbolic, formal, and technical language and operation, were quite well mastered, and the component of using mathematical tools, have not been able to be mastered. Students with fast accurate cognitive style were able to master communication, mathematizing, representation, devising strategies for solving problems, using symbolic, formal, and technical language and operation, and using mathematics tools very well, the component of reasoning and argumentation were quite well mastered. Students with slow-inaccurate cognitive style were quite well to master communication, mathematizing, reasoning and argumentation, devising strategies for solving problems, and using symbolic, formal, and technical language and operation, the components of representation and using mathematics tools have not been able to be mastered.

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INTRODUCTION

Every year, students' achievement in mathematics can be measured through the value of the national exam as a national rating scale. However, an assessment of mathematics achievement on international scale is important indicator as a reference in the evaluation of education of a country (Yalcin et al., 2012). The Organization for Economic Co-operation and Development (OECD) organized the PISA (Program for International Student Assessment) as one of international assessments this year.

PISA is international study in reading (reading literacy), mathematics (mathematics literacy), problem-solving literacy, and science (science literacy), and finance (financial literacy) (OECD, 2012). Literacy achievement of Indonesian students in PISA in secondary schools, for mathematics subjects, have a low-rank position. The assessment conducted by PISA in 2015 showed that Indonesia's position was still low, ranking 62 of 70 countries with an average score in the 386 mathematics field (OECD, 2016). Some findings showed that students' mathematical literacy ability, especially in secondary education which still tend to be low (Stacey, 2011; Fadholi et al, 2015). One of the factors that particularly in senior high level refers to low (Stacey, 2011; Fadholi et al, 2015). One factor causes low students' mathematics literacy in Indonesia is there is no habituation from the teacher so that students are less trained to solve PISA and TIMSS problems which are contextual, demanding reasoning (Diyarko & Waluya, 2016; Wardono & Mariani, 2017).

One of the prerequisites for someone to succeed in the 21st century is learning mathematics literacy (Murnane et al., 2012). The ability of mathematics literacy in PISA focuses on students' ability in analyzing, giving reason, and convey ideas effectively, formulate, solve, and interpret mathematical problems in various forms and situations (Stacey, 2010). The basic mathematical abilities in mathematics literacy according to Ojose (2011) are communication, mathematizing, representation, reasoning and argumentation, devising strategies for solving problems, using symbolic, formal, and technical language and operation, and using mathematics tools.

Mathematical literacy ability provide benefits for students' real life (Ozgen, 2013; Rughubar & Reddy, 2014). Students' ability to solve real problems learned at school and based on outside school experience is based on a mathematical process, namely horizontal mathematical and vertical mathematical. This process can be raised in learning using the Realistic Mathematics Education approach (Fauzan & Yerizon, 2013). RME is an approach with the paradigm that mathematics is a human activity, and learning mathematics means working with mathematics (doing mathematics) (Freudenthal in Wijaya, 2012). The RME approach can improve learning outcomes including mathematical literacy and student activities by presenting material that is appropriate to everyday life (Budiono & Wardono, 2014).

The teachers' role to create a mathematics community in the classroom is very strategic, the portion of teacher's role as a teacher must be proportional with his role as facilitator, participant, and even as friends in the classroom (Asikin & Junaedi, 2013). Rochmad & Masrukan (2016) stated that the main support in the success in the classroom is the teacher who uses the right learning model, varies, teaches well (good teaching), and using good questions (good question). One learning model that can be used as an alternative in improving math literacy ability is the Double Loop Problem Solving model.

The Double Loop Problem Solving Model (DLPS) is a problem-based learning model as Problem Based Learning (PBL) but has several variations. Huda (2013) stated that the DLPS model is a variation of learning with problem-solving that emphasizes on main causal search (causes) of problem arises. Jufri (2015) stated that Double Loop Problem Solving learning can improve students' mathematics literacy ability of the eighth-grade junior high school level.

In every learning activity, the students have a style which in accordance with their character to understand the material that is studied. One of them is the cognitive style of students. Teachers need to understand and consider the cognitive style of students in learning activities to obtain maximum learning outcomes. The problems regarding cognitive style are interesting objects to be studied by many contemporary researchers (Michalska & Lamparska, 2015). Cognitive style is a consistent way conducted by a person in capturing stimulus or information, how to remember, think, and solve problems, respond to a task or respond to various types of environmental situations (Mulyono, 2012). Cognitive style including behaviors, preferences, or habit strategies that differentiate individual styles in responding, processing, storing, and using information or various types of environmental situations, as well as understanding, remembering, thinking, and solving problems (Saraccho, 1997; Kozhevnikov, 2007; Shi, 2011). In line with Kogan (in Warli, 2013) defines cognitive style as individual variation in the style of feeling, remembering, and thinking, or as a way of distinguishing, understanding, storing, manifesting, and utilizing information.

This study more focused on the reflective-impulsive cognitive style introduced by Jerome Kagan in 1965. The reflective-impulsive dimension describes the tendency of children who persistent to show fast or slow when answering the problem situation with high uncertainty of answers (Kagan and Kogan, 1970). Grouping students based on these two aspects namely reflective, impulsive, fast-accurate, and slow-inaccurate groups (Warli, 2013; Warli & Fadiana, 2015).

The research problems of this study were (1) how is the quality of mathematics learning by using Double Loop Problem Solving model with RME approach, (2) how is the students' mathematical literacy ability in learning by using Double Loop Problem Solving model with RME approach reviewed from the cognitive style.

Based on those problems, the objective to be achieved in this study was to know the quality of learning by using Double Loop Problem Solving model with the RME approach and the students 'mathematical literacy ability by using the Double Loop Problem Solving learning with RME approach reviewed from the students' cognitive style. The quality of learning in this study was measured through three stages, namely planning, learning, implementing learning, and assessment of learning outcomes. This is based on Danielson's opinion (2011) he argued that the quality of learning, can be measured based on three stages, namely (1) the planning (preparation and preparation) stages, (2) the implementation stage (environmental classroom and instruction), and (3) the evaluation stage (professional responsibility).

METHOD

This study employed mixed method with concurrent embedded designs. The quantitative research used as a primary method. The qualitative research was secondary method in this study. Mathematical literacy ability reviewed from the students' cognitive styles analyzed quantitatively and then described qualitatively. This study was conducted in SMP Negeri 40 Semarang with the study population of the study was eighth-grade students and the samples of the study were students of grade VIII F and VIII B in the academic year of 2017/ 2018.

Data sources in this study were students who are obtained from the results of mathematics literacy ability test, the results of reflective-impulsive cognitive style test in the form of Matching Familiar Figures Test (MFFT), observation sheets of learning implementation, student activity sheets during the learning process, and results of interview math literacy ability. Quantitative data analysis consists of preliminary data analysis and analysis of the quality of learning.

Preliminary data were analyzed using prerequisite tests with normality, homogeneity, and mean equation. Furthermore, the assessment of learning quality has three stages namely the validation of the learning tools and instruments of the study, the calculation of the percentage of students' learning and activity implementation, and the calculation of learning outcomes in the form of mathematics literacy ability test scores. In calculating the final mathematics literacy ability test score, hypothesis testing is conducted to know the hypothesis answer of the research hypothesis whether the learning that has been carried out effective or not. Tests carried out on hypothesis testing include mean tests, classical completeness tests, proportion difference tests, and mean difference tests. Hypothesis testing can be carried out after testing the normality and homogeneity of the data on the final mathematics literacy ability test. Meanwhile, the qualitative data analysis conducted through three steps, namely data reduction, data presentation, and conclusion.

Based on the Preliminary data analysis by taking α = 5%, the results showed that the significance value for the preliminary data normality = 0.200 > 0.05. This showed that the preliminary data for both experimental and control classes are normally distributed. The results of the preliminary data homogeneity testing showed the significance value for the initial data homogeneity = 0.730 > 0.05. This indicated that the experimental class variance is the same as the control class variance. Next is the results of testing the similarity of the mean preliminary data. It has been shown earlier that the initial data variance of both classes is homogeneous, and the results obtained significance values of 0.292 > 0.05. This means that there is no mean difference between the experimental and the control class.

RESULTS AND DISCUSSION

Qualified learning is a sequence of activities that can improve the achievement of students' competence (Hightower, 2011). Measurement of the quality of learning at the planning stage is showed by the results of the validation of the learning tools that are compiled that has an average of 4.0 - 5.0 intervals with good and very good categories, it can be concluded that the learning tools and instruments are valid and feasible for research. The following is a detailed table of validation scores for learning devices and research instruments. The results of the validation of learning tools and research instruments are presented in the following Table 1.

Table 1. The Results of Validation of Learning Tools and Research Instrument

No.	Learning Tools & Instruments	Validation Result	Category
1	Syllabus	4.23	Very Good
2	Lesson Plan	4.35	Very Good
3	Student's Worksheet	4.33	Very Good
4	Test of Mathematics Literacy Ability	4.30	Very Good
5	Observation Sheet of Learning Process	4.33	Very Good
6	Observation Sheet of Students' Activity	4.33	Very Good
7	Interview guidelines	4.37	Very Good
8	Quiz	4.17	Good

Based on Table 1, the result of validation of learning tools and research instrument arranged have an average on intervals of 4.0 - 5.0 with good and very good categories. Syllabus, Lesson Plan, Student's Worksheet, Test of Mathematics Literacy Ability, Observation Sheet Learning Process, Observation Sheet Students' Activity, and Interview guidelines are in a very good category and Quiz is in a good category. It can be concluded that learning tools and research instrument are compiled valid and appropriate for research.

The results of the MFFT of student's grade VIII F SMP Negeri 40 Semarang is presented in the following Table 2.

Table 2. The Results of Students Matching Familiar Figures Test

Characteristics of Cognitive Style	Total	Percentage
Reflective	9	25
Impulsive	10	27.78
Fast-Accurate	1	2.78
Slow-Inaccurate	16	44.44
Total	36	100

Based on Table 2, the results of students Matching Familiar Figures Test showed that 9 students with a percentage of 25% of cognitive style reflective, 10 students with a percentage of 27.78% cognitive style impulsive, 1 student with a percentage of 2.78% cognitive style fast-accurate, and 16 students with a percentage of 44.44 % cognitive style slow-inaccurate. The selection of subjects of the study is based on MFFT results. Subjects selected for the cognitive reflective style were 2 students with SP-17 and SP-33 as the subject of the interview. Reflective subjects were taken based on the consideration of the longest and most accurate time record. The subjects selected for the characteristics of impulsive cognitive style were 2 students with SP-5 and SP-36 as the subject of the interview. The subject of impulsive was taken based on the consideration of the fastest and the least accurate time record. Selected subjects for fast-accurate cognitive style characteristics were 1 student with SP-28 as the subject of the interview. The fast-accurate subject was taken because it was the only student with the fastest and most accurate time record. Furthermore, the selected subjects for the cognitive style characteristics of slow-inaccurate are 2 students with SP-6 and SP-20 as the subject of the interview. The slow-inaccurate subject was taken based on the consideration of the longest and least accurate time record.

The quality of learning implementation in this study was measured based on two observations, namely the observation of the implementation of learning and observation of student activities. Student activities need to be observed to determine the impact of the learning process on the quality of learning (Luskova & Hudakova, 2013). In teaching and learning activities, students solve the problem by doing problem identification, detect the cause directly, and applied the temporary solution, evaluate the solution by comparing and discussing the answer and decide whether the deeper analysis is needed or not, and implement the main solution as well as.

The percentage of learning achievement at the first meeting was 73.33% in the good category, the second meeting was 84.44% in the very good category, the third meeting was 92.22% in the very good category, and the fourth meeting was 93.33% in the very good category, so that the average of learning achievement obtained was 85.83% in the very good category. The percentage of student activity at the first meeting was 76.88% in the good category, the second meeting was 84.03% in the very good category, the third meeting was 87.01% in the very good category, and the fourth meeting was 89.83% in the very good category, so that the average percentage of students' activity in learning was 84.44% in the very good category. Based on these results, it can be concluded that the implementation of learning with the Double Loop Problem Solving model approaching RME has been carried out by qualified researchers in a very good category.

The assessment of learning outcomes in this study was measured based on hypothesis testing including the mean test, classical completeness test, proportion difference test, and mean difference test. Before carrying out the test, the final mathematics literacy ability test data used must be tested to ensure that the data obtained is normal and homogeneous. Based on the results of testing the final data normality by taking α= 5%, with a significance value obtained for the final data normality = 0.054 > 0.05. This showed that the final data for both experimental and control classes are normally distributed. Furthermore, on the results of testing the final data homogeneity, obtained the significance value for the final data homogeneity = 0.819 > 0.05. This showed that the final mathematics literacy ability test variance in the experimental class is the same as the final mathematics literacy ability test variance of the control class.

Hypothesis test analysis includes mean test, classical completeness test, proportion difference test, and mean difference test. The mean test of mathematics literacy ability based on KKM is used to determine the mean mathematics literacy ability of students beyond KKM or not. As for the KKM, the ability of mathematical literacy used is 68. Based on the calculation of the mean test, obtained a significance value (α) = 0.000 < 0.05. It means that the mean score of the mathematics literacy ability of students in the experimental class reaches the minimum completeness criteria limit.

The classical completeness seen from the proportion of students who completed the KKM exceeded 75% or not. Based on the final mathematics literacy ability test results of the experimental class, it was obtained data that students who achieved KKM were 33 students, of the total students in the experimental class were 36 students. Then from the available data, the calculated value obtained z = 2.31. The value of $z_{\frac{1}{2}(1-\alpha)} = z_{\frac{1}{2}(1-0,05)} = z_{0,475} = 1,96$. Since the value of $z = 2,31 > z_{0,475} = 1,96$. This means that the proportion of students completing in the learning model subject to the DLPS model with RME approach is more than 75%.

Proportion difference test was used to find out the difference in the number of students who achieved the completeness of mathematical literacy ability in Double Loop Problem Solving (DLPS) model with RME approaches and the number of students who achieved the completeness of mathematical literacy ability in the PBL model. Based on the results of the final mathematics literacy ability test, obtained data based on calculation = 0.75. The value of $z_{\alpha} = z_{0,05} = 0,12$. Since the value of $z = 0,75 > z_{0,05} = 0,12$ therefore, the proportion of students 'mastery of mathematics literacy ability who are taught by using the DLPS model with RME approach is better than proportion of students 'mastery of mathematics literacy ability taught by using the PBL model.

The mean difference test was used to find out the differences in students 'abilities in the class with the RME approach DLPS model and the students' ability in the class with the PBL model. Based on the results of the mean difference test between the experimental and control classes, the results obtained significance values $0{,}005 < 0{,}05$. It means that the mean of students' mathematics literacy ability in the class taught by using the DLPS model with RME approach is more than the mean of students' mathematics literacy ability in the class with the PBL model.

Generally, students with reflective cognitive style have good mathematical literacy ability. This is indicated by the students 'reflective ability in mastering four of the seven components of students' mathematical literacy abilities. Students with reflective cognitive style were able to master communication, mathematizing, reasoning and argumentation, and devising strategies for solving problems very well, the components of representation, using symbolic, formal, and technical language and operation, and using mathematics tools were quite well mastered. Students with impulsive cognitive style have prominent mathematical literacy abilities in the communication component. Impulsive students were able to master the communication component which is shown by the ability to write questions and statements presented in the problem in a complete and precise manner. While for the other five components of mathematical literacy which include mathematizing, representation, reasoning and argumentation, devising strategies for solving problems, and using symbolic, formal and technical language and operation, were quite well mastered and the component of using mathematical tools, have not been able to be mastered. This is because impulsive students tend to be in a hurry so that they are less careful in answering questions. Students with fast-accurate cognitive styles stand out in almost all components of math literacy abilities. Student with fast-accurate cognitive style did not find many problems in solving problems. Students with fast accurate cognitive style were able to master communication, mathematizing, representation, devising strategies for solving problems, using symbolic, formal, and technical language and operation, and using mathematics tools very well, the component of reasoning and argumentation were quite well mastered. Students with slow-inaccurate cognitive style have less mathematical literacy ability than students in other cognitive style groups. There are various kinds of constraints for slow-inaccurate students in solving the given problem. Students of slow-inaccurate are constrained by long working hours and many considerations in solving problems. Students with slow-inaccurate cognitive style were quite well to master communication, mathematizing, reasoning and argumentation, devising strategies for solving problems, and using symbolic, formal, and technical language and operation, the components of representation and using mathematics tools have not been able to be mastered.

Based on the results of mathematics literacy ability test and interviews with the research subjects, information was obtained that reflective students tend to be considerate in thinking and making decisions. They need more time to work on the problem but with a high degree of accuracy. Impulsive students have fluent tendencies in answering problems, not thinking deeply, and not considering other solutions in solving problems. Students with fast-accurate tend to think fast and precisely in answering problems, meanwhile, slow-inaccurate students tend to need more time to think and make decisions but tend to be less careful.

These results in line with Vendiagrys et al, (2015) which confirms that there is a relationship between cognitive style and mathematics learning outcomes. Purnomo et al, (2015) stated that in solving mathematical problems and considering decisions, reflective students think long and deep while impulsive students are fluent in answering the problems have given, tend to think less deeply and provide simple answers in accordance to the questions. Rahmawati (2017) states that in relation to work on mathematics questions, fast-accurate students tend to think quickly and accurately while slow-inaccurate students tend to need more time to make decisions and less careful.

CONCLUSION

learning by using the double loop problem solving model with RME approach on the mathematics literacy ability of students is good quality. The analysis of mathematical literacy ability reviewed from the students 'cognitive style showed that students with reflective cognitive style were able to master communication, mathematizing, reasoning and argumentation, and devising strategies for solving problems very well. Students with impulsive cognitive style were able to master communication very well. Students with fast accurate cognitive style were able to master communication, mathematizing, representation, devising strategies for solving problems, using symbolic, formal, and technical language and operation, and using mathematics tools very well. Students with slow-inaccurate cognitive style were quite well to master communication, mathematizing, reasoning and argumentation, devising strategies for solving problems, and using symbolic, formal, and technical language and operation.

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