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Mathematical representation ability and curiosity of 8th graders in the 7E-Learning Cycle model with realistic approaches

Dina Dwi Astuti[a,*], Budi Waluya[a], Edy Soedjoko[a]

[a] *Department of Mathematics, Universitas Negeri Semarang, Sekaran, Gunungpati, Semarang 50229, Indonesia*

** E-mail address: dinadwiastuti@students.unnes.ac.id*

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Abstract

This study aimed to test the effectiveness of 7E-learning cycle learning with realistic approaches for students' mathematical representation ability and describe the students' mathematical representation ability from the view of students' curiosity. This study used a mixed-method with a concurrent embedded model. The population of this study was 8th graders in a Junior High School in Patebon, Kendal. Random sampling was used to obtain 32 students for the experiment class and 32 students for the control class. For the qualitative analysis, two students for each high, medium, and low curiosity level were selected. Questionnaires, tests, interviews, and documentation were used to collect data. T-test, classical completeness Z-test, the mean difference test, and proportions different tests were used to analyze the data quantitatively. Meanwhile, qualitative data were analyzed using data reduction, data display, conclusion drawing, and verification. The results show that 7E- learning cycle learning with realistic approaches affected students' mathematical representation abilities positively. The study also revealed that students with high, medium, dan low curiosity levels show different perform in mathematics representation.

1. Introduction

Mathematics is one of the sciences that is learned and taught at every level of education. Mathematics subjects need to be given to all students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to work together. This ability is needed so that students can process, manage, and use the information to survive in a situation that is always changing, uncertain, and competitive.

International Survey Program for International Student Assessment (PISA) in 2015 shows that Indonesia ranked 65 out of 72 countries in the field of mathematics (OECD, 2016: 5). It shows that the mathematical ability of students in Indonesia has not been optimal, and in solving daily realistic problems.

National Council of Teachers of Mathematics (2000) in the Principles and Standards of School Mathematics states that the purpose of giving mathematics lessons is to develop comprehension and evidence, communication skills, connection skills, and representational skills. One of the goals of giving mathematics lessons, according to NCTM, is to develop representation ability. Students in the middle class solve many problems where they create and use representations to organize and record their thoughts about mathematical ideas.

Mathematical representation is a high-level ability that can lead students to structured thinking patterns and can develop their thinking ability in developing their understanding (Pakarti, 2016). Mandur (2013) states that the mathematical representation ability contributes significantly to mathematics learning achievement both directly and indirectly. Therefore, to improve students' mathematics learning

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achievement, it is necessary to improve their mathematical representation ability. Furthermore, Keller & Hirsch (Venkat & Essien, 2011) state that the use of representations in mathematics learning allows students to concretize some concepts that can be used to reduce learning difficulties until mathematics becomes more interactive and interesting and can facilitate students to connect cognitive to representation. Representation ability is divided into three types, namely: (1) visual representation in the form of diagrams, graphs, or tables, and images; (2) mathematical equations or expressions; and (3) written words or texts (Yudhanegara, 2015).

Students can develop and deepen their understanding of mathematical concepts and the relationships that they create, compare, and use various representations. Besides, to be able to communicate their understanding, students need representation in the form of pictures, graphs, diagrams, and other forms of representation. Therefore, mathematical representation ability needs to get serious attention in the process of learning mathematics in schools.

The results of the 2015 Trends International Mathematics and Science Study (TIMSS) survey shows that mathematical abilities in Indonesia are low in competitiveness with other countries. Indonesia is ranked 45th out of 50 countries surveyed with an average score in Indonesia for class IV of 397. One of these mathematical abilities is the ability of representation. This can be seen when students are asked to represent data on the tables into graphical form; the level of achievement is only 30% from the international average of 51%. This shows that the representation ability of students in Indonesia is still low.

The purpose of mathematics subjects in schools, according to Ministerial Regulation No. 22/2006, is that students can: (1) understanding mathematical concepts, explain inter-conceptual relationships, and apply the concepts or algorithms flexibly, accurately, efficiently, and precisely in problem-solving; (2) using reasoning on patterns and traits, doing mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements; (3) solving the problems that include the ability to understand problems, designing mathematical models, solving models, and interpreting the solutions obtained; (4) communicating ideas with symbols, tables, diagrams or other media to clarify the situation or problem; (5) having an attitude of appreciating the usefulness of mathematics in life, namely curiosity, attention, and interest in learning mathematics, as well as a tenacious and confident attitude in problem-solving. Based on the above objectives, mathematics lessons not only focus on mathematical abilities but also on the formation of students' attitudes. One of such attitude is curiosity.

The Ministry of National Education (2011) states that curiosity includes attitudes and actions that always try to find out more deeply and extensively from something that is learned, seen, and heard. There are four indicators of students' curiosity, namely: (1) asking the teacher and friends about the subject matter, (2) trying to find from the source of learning about the concepts/problems that are learned/encountered, (3) trying to find more challenging problems, (4) active in finding information.

Student curiosity can be characterized by the high student attention to the lesson, often asking questions and active in finding information. Nurfauziyah (2015) in her research states that the result of observations of the learning process shows that there are students who talk with friends outside of the subject matter 22%, are engrossed outside the lesson 18%, leaned on the desk 9%, ask the questions 20%, note the material delivered by teachers 45% and students who collect assignments from teachers 86%. Based on the description, it can be said that students' curiosity is still lacking. Furthermore, the results of an interview with one of the eighth-grade mathematics teachers of SMP Negeri 2 Patebon Kendal, it is known that the scores of the 2016/2017 student daily tests are incomplete or do not reach the Minimum Mastery Criteria (KKM), which is set at 75. He said that it is caused by students' mathematical abilities that have not been optimal such as reasoning and represent mathematical problems. Adding with a lack of curiosity and students’ interest in learning mathematics. This can be seen from the activeness of asking students who are decreasing every year and also the willingness of students to look for other learning resources that are very lacking.

Ameliah (2016) states that there is a significant influence between students' curiosity with learning outcomes. Furthermore, Rene R. Belecina and Jose M. Ocampo (2016) state that students with high levels of curiosity tend to have high learning outcomes.

Remembering that the level of students' mathematical representation ability is still low, it is necessary to make improvements in the learning process to improve students' mathematical representation ability.

Aunurrahman, as quoted by Setiawan (2015), states that the use of appropriate learning models can encourage students to feel happy about the lesson and be able to achieve better learning outcomes. The selection of the learning model, which is appropriate, is expected to be able to maximize the process and student learning outcomes. One of the learning models that can be used is the 7E-learning cycle.

The 7E-learning cycle model can construct and develop reasoning power. Learning the 7E-learning cycle is student-centered learning. With the 7E-learning cycle model, through its principles and characteristics, it will be able to improve high-level mathematical abilities, one of which is the ability of students' mathematical representation. Also, the Engage phase is the phase that is used to focusing student interest and generating interest in opening up knowledge and stimulating student curiosity. Laelasari (2014) states that there is a significant increase in the ability of representation in students who obtain learning by using the 7E learning cycle.

However, 7E-Learning Cycle has a weakness; one of them is to demand the sincerity and creativity of teachers in stimulating and implementing the learning process. The efforts that can be made to overcome the weaknesses of the 7E-learning cycle learning model include creating an interesting learning atmosphere so that learning is more meaningful. One way to create an interesting and meaningful learning atmosphere is by using a realistic approach. Wijaya, as quoted by Sahara (2017), states that learning using a realistic approach can at least make mathematics more interesting, relevant, and meaningful, not too formal, not too abstract, and emphasizes the learning in 'learning by doing'. Pakarti (2016), in his research, shows that the RME approach is better than conventional learning in improving students' mathematical representation ability on comparison and scale material.

The purpose of this study is (1) to test the effectiveness of the 7E-learning cycle with a realistic approach to the mathematical representation ability of grade VIII students in mathematics learning, (2) to describe the mathematical representation ability of grade VIII students who obtain learning by using the 7E-learning cycle with a realistic approach in terms of student curiosity.

The effectiveness of this study is the success of the learning model applied using the 7E-learning cycle learning model with a realistic approach. Indicators of the effectiveness of the 7E-learning cycle learning model with a realistic approach are (1) the ability of mathematical representation of students who obtain 7E-learning cycle with a realistic approach can achieve mastery learning, (2) the mathematical representation ability of students who obtain the 7E-learning cycle with realistic approaches is better than the mathematical representation ability of students who obtain expository learning model. It is said to have reached mastery learning when achieving average value completeness and classical completeness. Average value completeness means the average student test results are more than or equal to 75. While classical completeness means the proportion of students who score more than or equal to KKM value reaches more than or equal to 75% of the number of students in the class.

2. Method

The type of research was a combination research method or a mixed method, which was a research method that combined quantitative and qualitative methods to be used together in research activity to obtain more comprehensive, valid, reliable, and objective data. The mixed-method that used was concurrent embedded, which was a method that combined quantitative and qualitative methods unevenly and at one time (Sugiyono, 2015).

The research that was used as an experimental study that refers to the Posttest Only Control Group Design. The design of the study was shown in Table 1.

Table 1. Research Design

Class	Treatment	Post-test
Experiment	X	T
Control	-	T

Description:
X: 7E-LC application with a realistic approach
T : posttest (same problem)

The population in this study were all students of class VIII at SMP Negeri 2 Patebon in the academic year 2017/2018. The population of 258 students was divided into eight classes, namely VIII A, VIII B, VIII C, VIII D, VIII E, VIII F, VIII G, and VIII H. Class placements are conducted randomly, so there are no superior classes in terms of academic achievement.

Sampling was done by a random sampling technique, which took class VIII B as the experimental class and class VIII D as the control class. Class VIII B consists of 32 students, and class VIII D consists of 32 students. The experimental class was a class that received the treatment model of the 7E-learning cycle with a realistic approach, while the control class was a class with expository learning.

Determination of the subject in this study by using purposive sampling techniques with consideration of grouping the results of students' curiosity questionnaires, advice from teacher teachers, and answers to students' mathematical representation ability test. The subjects who chosen for qualitative research were six students consisting of two students with high curiosity, two students with medium curiosity, and two students with low curiosity.

The study began with a preliminary study to identify problems in the field by conducting studies on data, interviews with teachers, and studies in the literature. Furthermore, researchers conducted quantitative and qualitative research. Quantitative research is to test the effectiveness of 7E-learning cycle learning with a realistic approach, while qualitative research is to determine the description of mathematical representation abilities based on students' curiosity. This qualitative data was obtained through interviews with research subjects that were determined based on the grouping of students' curiosity.

Data collection techniques used in this study include questionnaires, tests, interviews, and documentation. Questionnaires were used to obtain curiosity data, which are then used to group students into three categories, namely high, medium, low. Questionnaires are arranged based on indicators of curiosity, namely (1) asking the teacher and friends about the subject matter, (2) trying to find from the source of learning about the concepts/problems that are learned/encountered, (3) trying to find more challenging problems, (4) active in finding information. The test is a Mathematical Representation Ability Test (TKRM). The test was used to obtain data on the results of students' mathematical representation abilities. Interviews were used to obtain data directly about the mathematical representation ability of students in solving problems on test questions. The interview is an unstructured interview where the interview questions submitted are adjusted to the conditions of students’ TKRM results and can develop based on the answers of research subjects. Documentation was used to complete data collection techniques with questionnaires, tests, and interviews.

Quantitative data analysis techniques were performed on initial data and final data. The initial data analysis technique consisted of a normality test, a homogeneity test, and a two-average similarity test. While the final data test included average value completeness tests using a t-test, classical completeness test using the z test, two average tests, and a different test of two proportions. Qualitative data analysis included data reduction, data display, and conclusion drawing/verification.

3. Results & Discussions

Based on the first data analysis, it shows that the experimental class and the control class are normally distributed and have the same variance (homogeneous). The results of the average similarity test are obtained that there is no significant difference in the average of the two classes. This shows that the experimental class and the control class come from the same conditions.

The implementation of learning in the experimental class uses the 7E-learning cycle model with a realistic approach, and the control class uses an expository model. Learning in each class is carried out as many as four meetings and one meeting for the test so that many meetings of each experimental and control class are five meetings.

At the final meeting, students in the experimental class are given a questionnaire of curiosity. Grouping students based on the results of the curiosity questionnaire can be seen in Table 2.

Table 2. Grouping students based on curiosity

Category	Number of Students	Percentage
High	5	15,625
Medium	22	68,75
Low	5	15,625
Total	32	100

In each category, two students are chosen to be analyzed more deeply about their representation abilities. Two students selected in the high category are students with the highest curiosity score or SET1 and students with the lowest curiosity score or SET2 in the student group of that category. Two students selected in the medium category are students with the highest curiosity score or SES1 and students with the lowest curiosity score or SES2 in the group. Two students selected in the low category are students with the highest curiosity score or SER1 and students with the lowest curiosity score or SER2 in the group.

After conducting a series of studies, data was obtained from the Mathematical Representation Ability Test (TKRM). Next, to test the effectiveness of the 7E-learning cycle learning with a realistic approach, a statistical test is performed on the TKRM data. The statistical tests carried out are average value completeness test, classical completeness test, two average tests, and two proportional relief test.

The average value completeness test uses the t-test, which is a party test of the average. The result of the test is obtained $t_{hitung} = 4{,}408 > t_{tabel}$ =1,70 so that H_0 is rejected and H_1 accepted. So, it can be concluded that the results of the average of students' mathematical representation ability tests are more than 75. The classical completeness test uses the proportion test that is the z test. The result of the test is obtained $z_{hitung} = 2{,}041 > z_{tabel}$ =1,64 so that H_0 is rejected and H_1 accepted. So, it can be concluded that the proportion of students who have finished learning in class by using the 7E-learning cycle learning model with a realistic approach of more than 75%. The average similarity test uses a one-party t-test. The result of the test is obtained $t_{hitung} = 1{,}696 > t_{tabel} = 1{,}67$ so that H_0 is rejected and H_1 accepted. So, it can be concluded that the average mathematical representation ability of students with the 7E-learning cycle learning model with a realistic approach is more than the average mathematical representation ability of students with expository learning. Test the difference in the two proportions by using the one-party proportion test, the z test. The result of the test is obtained $z_{hitung} = 1{,}71 > z_{tabel} = 1{,}64$ so that they are H_0 rejected and H_1 accepted. So, it can be concluded that the proportion of students who complete learning in class with the 7E-learning cycle learning model with a realistic approach is higher than the proportion of students who complete in class with expository learning. Based on the description above, it can be said that the 7E learning cycle with a realistic approach is effective in the ability of mathematical representation.

This is under the Vigotsky learning theory, as quoted by Harjali (2016), that is the learning process will occur effectively and efficiently if the child learns cooperatively with other children with an atmosphere that supports the guidance or accompaniment of someone more capable, for example, a teacher. Laelasari's research (2014) shows that there is a significant increase in the representation ability in students who obtain learning using the 7E learning cycle. Furthermore, Pakarti's research (2016) shows that the RME approach is better than conventional learning in improving students' mathematical representation abilities on comparison and scale material. Lestari (2014) states that the application of the RME approach can improve student learning outcomes.

Students with high curiosity can solve problems well. The results of TKRM and interviews show that SET1 can present problems correctly in the graph and can make conclusions or solutions obtained based on graphs. Likewise, in SET2 can draw a Cartesian chart and can make conclusions based on the graph made. So, it can be concluded that subjects with high curiosity ability can restate data/information from representation to the representation of diagrams, graphs, or tables. SET1 can make mathematical models of problems and can do mathematical calculations to solve given problems. Furthermore, SET2 can make mathematical models correctly and can find solutions to problems with the correct calculations. So, it can be concluded that subjects with high curiosity ability can make equations, mathematical models, or representations of other representations given and solve problems by involving mathematical expressions. Furthermore, both SET1 and SET2 can mention information that is known and asked in the problem. So, it can be said that subjects with high curiosity ability can arrange stories that accordance with a given representation.

The results of TKRM and curious subject interviews are showing that SES1 and SES2 have not been able to draw a Cartesian chart. So, subjects with curiosity skills are less able to restate data/information from representation to the representation of diagrams, graphs, or tables. SES1 can make mathematical models and can do mathematical calculations well. SES2 is also able to make mathematical models and do mathematical calculations well. So, it can be said that subjects with curiosity skills can make equations, mathematical models, or representations of other given representations and solve problems by involving mathematical expressions. Furthermore, both SES1 and SES2 can mention information that is known and asked in the problem. So, it can be said that subjects with high curiosity ability can arrange stories that accordance with a given representation.

The results of TKRM and interviews of subjects with low curiosity show that SER1 and SER2 have not been able to draw a Cartesian chart of the questions given. Thus, subjects with low curiosity skills are less able to restate data/information from representation to the representation of diagrams, graphs, or tables. SER1 and SER2 have not been able to make mathematical models correctly and have not been able to solve problems using mathematical calculations correctly. So, it can be said that subjects with low curiosity ability are less able to make equations, mathematical models, or representations of other representations given and solve problems by involving mathematical expressions. Furthermore, SER1 and SER2 can mention information that is known and asked from the questions given. So, it can be said that subjects with low curiosity ability can arrange stories that accordance with a given representation.

Ameliah (2016) which states that there is a significant influence between students' curiosity with learning outcomes. Furthermore, Balecina's research (2016) states that students with high levels of curiosity tend to have high learning outcomes. Furthermore, Yoga Wicaksana, Wardono, & Saiful Ridlo (2017) stated that the abilities that have the effect of increasing the character of epistemic curiosity include communicating, mathematizing, representation, reasoning, using symbolic formal and technical operations, and using mathematics tools.

Based on the results of research and support from several relevant research studies, it can be concluded if curiosity influences students' mathematical representation abilities. Students with high and medium curiosity have the ability to solve problems of good mathematical representation, while students with low curiosity have poor mathematical representation abilities. This is because students who have high curiosity are more active in the learning process, and more active in paying attention to the explanations given, and tend to try to find the answers to the problems that are found by asking the teacher or friends. Students with medium curiosity are active in paying attention to learning, but when faced with difficult problems, he tends to ignore and not try to find answers or ask the teacher or a friend. Students with low curiosity are less active in learning and tend not to focus when learning takes place, and are not interested in reading or re-learning the material which is presented so that students' motivation in learning is lacking.

4. Conclusion

Based on the results of research and discussion, it is concluded that the 7E learning cycle with a realistic approach is effective on students' mathematical representation abilities. Students with high curiosity have fulfilled all indicators of mathematical representation ability, namely in visual representation, symbolic representation, and word representation. Students with medium curiosity have not fulfilled all indicators of mathematical representation ability, namely students have fulfilled indicators on symbolic representations and word representations, but have not yet fulfilled indicators of visual representation. Students with low curiosity fulfill the indicators of representation of words but have not fulfilled the other two indicators of mathematical representation ability, namely visual and symbolic representation.

From this conclusion, 7E-learning cycle learning with a realistic approach can be used as an alternative for teachers to be applied in the classroom to improve students' mathematical representation abilities. For students with low curiosity, teachers can provide additional guidance in person so that students have the self-confidence that can motivate students during learning so that students' curiosity can develop. Furthermore, for students with medium curiosity, the teacher can motivate so that students are more confident active in learning and not hesitate to ask the questions when facing learning difficulties so that they are more optimal in solving mathematical problems.

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