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The Analysis of Problem-Solving Ability by Considering Students' Curiosities in the 7E Learning Cycle Model with Ethno-Mathematical Nuances

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Abstract

This study aims to describe students' problem-solving abilities by considering their curiosities. The subjects in this study are determined based on the analysis of the results of the Curiosity Inventory in class VIIIA students of SMP N 1 Bandungan, Semarang Regency. Students are grouped into two types, namely the type of Epistemic Curiosity (EC) and the type of Perceptual Curiosity (PC). The EC group are taken by two students, namely a weak *(Lemah)* EC (ECL) and a strong *(Kuat)* EC (ECK), as well as the PC group taken by two students, namely a weak PC (PCL) and a strong PC (PCK). This research is a mixed method research with a sequential explanatory design. The data collection techniques use questionnaires, tests and interviews. The effectiveness is analyzed based on (1) the average similarity test; (2) completeness test and average difference test. Based on data analysis, the results of tests and interviews show that the ECL type students can understand problems, plan solutions, and carry out the completion plans, but are unable to check again. ECK type students can understand the problem until it checks again properly. The PCL type students can understand the problem but are less able to plan solutions and carry out the completion plan and are unable to check again. The PCK type students can understand problems, plan completion plans and carry out completion plans but are less able to check again.

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INTRODUCTION

Mathematics is the source of other sciences, in other words many sciences whose discovery and development depend on mathematics. For example, many theories and branches of physics and chemistry (modern) are discovered and developed through the concept of calculus. In particular about Differential equations; Discovery and development of Mendel's theory in biology through the concept of probability; The Economic Theory of Supply and Demand developed through the concept of Functions and Calculus on Differentials and Integral (Suherman et al., 2003, p. 25).

The results of the Trends in International Mathematics and Science Study (TIMSS) in 2011 Indonesia was ranked 38 out of 42 countries with an average score 386. The results of the Program for International Student Assessment (PISA) survey, in 2012 Indonesia was ranked 71st out of 72 countries, while in 2015 Indonesia moved up six places to rank 64 out of 72 countries. This shows that learning mathematics in Indonesia needs to be improved. Based on The Policy of Ministry of Cultural and Education (*Permendikbud) No*. 21 of 2016 regarding the content standards of primary and secondary education, one of the competencies that will be achieved in the learning process of mathematics is problem solving ability. Problem solving is the essence and has a role as the core of the realm of competence in the implementation of the mathematics learning process.

Based on the results of preliminary observations at SMP N 1 Bandungan Semarang Regency, there are still many students' difficulties in learning mathematics. The most common difficulty encountered is problem solving skills. Apart from the factor of student difficulty in learning because the learning process has not been effective and is more educator centered. Ruseffendi (1991) states that so far in the process of learning mathematics in class, generally students are only told by their teachers and not through exploration activities. With learning like this, the participation and activeness of students in following the learning process is not optimal. Teachers also have not developed a curriculum by looking at the characteristics of students and the potential that the school has. This has an impact on the low ability of students to solve problems.

Based on these facts, it is necessary to strive for learning with a certain approach or method that is fun to increase curiosity and problem solving. Among them is the 7E Learning Cycle model. According to Simatupang (2008) Learning cycle is a student-centered learning model. The stages of learning activities are designed so that students can master a number of competencies that must be achieved through student activity roles. Sadi & Carikoglu (2010) also revealed that the learning cycle model is used as an alternative learning strategy to instill a deep understanding of students so that it will have an impact on improving students' learning outcomes. Carin (1997) explains that the learning cycle model is one of the learning models that is in accordance with Piaget's learning theory and other cognitive learning theories. This is because the learning cycle involves three interactions, namely physical knowledge, social knowledge, and self-regulation.

Jones in (Shockey & Bear, 2006, p. 71) defines ethnomatematics as a multicultural mathematical activity that uses culture to make connections with typical mathematical topics. Ministry of National Education (2010, p. 24) curiosity is an attitude and action that always seeks to know more deeply and broadly from something one has learned, seen, and heard. Therefore, the problem-solving ability in this study will be reviewed from the perspective of curiosity as a qualitative domain. This study seeks to describe students' problem-solving abilities according to the classification of the type of curiosity they have.

Based on the previous description, the objectives of this study are (1) to analyze the effectiveness of student learning in the application of the 7E Learning Cycle model with ethnomatematic nuances in improving students' problem-solving abilities; and (2) to analyze mathematical problem-solving abilities in the application of the 7E Learning Cycle with ethnomatematic nuances in terms of student curiosity. The effectiveness of this study is to analyze through (1) the learning device used had minimum good criteria; (2) learning in the experimental class using the 7E Learning Cycle model with ethno-mathematical nuances can achieve completeness; (3) the average problem-solving ability of students in classes taught using the 7E Learning Cycle model with ethno-mathematical nuances is more than KKM and (4) the problem-solving ability of students in the experimental class using the 7E Learning Cycle model with ethnomatematic nuances more than the control class using the model direct learning.

Suherman et al (2003, pp. 25–26) argue that mathematics grows and develops for itself as a science, as well as to serve the needs of science in its development and operation. Mathematics has a major role in the learning process. One of the abilities that must be improved is problem solving skills as part of High Order Thinking Skill (HOTS). Polya (1957) revealed that there are four stages that must be carried out in the problem-solving process. The four stages include, 1) understanding the problem (understand the problem); 2) determine a plan (devising a plan); 3) carrying out as planned (carrying out the plan); 4) looking back. NCTM (2000, p. 52) states that problem solving is an integral part of learning mathematics and cannot be separated from programs contained in mathematics. The problem solving in this study is carried out according to Polya's problem solving stages with NCTM indicators.

The 7E Learning Cycle model is a learning model that emphasizes the ability to instill concepts and the ability to connect mathematical ideas and real phenomena. Learning Cycle 7E mathematics model is expected to be more meaningful when it is developed using nuances that are close to the daily world of students such as ethno-mathematics so that it can improve problem-solving abilities.

Ethnomatematics is the practice of mathematics from identifiable cultural groups, and it can be considered as the study of mathematical ideas found in each culture (D'Amborsio, 1985).

Levitt (1954) divides curiosity into two dimensions (aspects), namely Epistemic Curiosity (EC) and Perceptual Curiosity (PC), Epistemic Curiosity or epistemic type curiosity is defined as curiosity that arises because it is motivated by a lack of knowledge. It is also defined as curiosity that comes from one's own urge to know something, while Perceptual Curiosity or perceptual curiosity is defined as curiosity that arises because it is motivated by sensory stimuli or needs (Levitt et al., 2009). Each individual must have a different background of curiosity, so that the information processing process during the problem-solving analysis will also differ according to the perspective of curiosity.

METHOD

This study uses a combination method or mixed methods type sequential explanatory. Analysis of problem-solving abilities is analyzed based on Polya's stages with the NCTM indicators described in Table1.

Table 1. The Polya's Problem Solving Stage with NCTM Indicators

Polya's Stages	NCTM Indicators
Understanding the Problem	Write down what is known Write down the thing that was asked Write a sketch of the problem
Develop the Problem-Solving Plan	Develop a problem-solving plan based on the facts provided, prerequisite knowledge, and clear procedures Estimating the strategies that will be used in problem solving. Able to simplify problems Be able to sort information
Doing a Problem-Solving Plan	Translating the problem given in the form of mathematical sentences Solve the problem with a predetermined strategy Take decisions and actions by defining and communicating conclusions
Re-checking the Problem-Solving Results	Checking the correctness of the results at each step taken in solving the problem Able to make a coclusion on solutions of problems that have been resolved Arrange the problem solving with different steps

The results of the analysis of problem-solving abilities as quantitative dominate and are used as a basis for data information that will then be strengthened by analysis based on curiosity as a qualitative domain. The curiosity analyzed in this study is the type of curiosity Epistemic Curiosity (EC) and Perceptual Curiosity (PC).

Through a random sampling system, this study selected class VIIIA as the experimental class and class VIIIB as the control class. The experimental class was taught using learning with the 7E Learning Cycle model with ethno-mathematical nuances and the control class was taught using the direct learning model. The initial ability test and problem-solving ability test were carried out in the experimental class and the control class. Through the experimental class, 4 students who have the curiosity of EC and PC were taken two students each to be analyzed qualitatively. Two students with weak EC (ECL) and strong EC (ECK) characters, as well as students who had PC curiosity, two students with weak PC (PCL), selected students with EC curiosity and strong PC (PCK) characters were selected, and then the analysis was carried out based on the results of the problem-solving ability test and interviews with data triangulation.

Data collection techniques in this study consisted of questionnaires, tests, and interviews. The type of test in this study is a problem-solving ability test that is carried out at the beginning and at the end of learning. The data analysis was carried out from the time before in the field to the analysis stage while in the field. The analysis before being in the field was carried out by validating the research tools and instruments. Analysis of quantitative data obtained from the problem-solving ability test data, consisting of average equality test, completeness test, and average difference test. While qualitative data analysis is done by reducing data, presenting data, and drawing conclusions from the data that has been collected and verifying these conclusions on subjects who have been selected based on the classification of curiosity.

RESULT AND DISCUSSION

The results of this study are described in two stages, namely quantitative research and qualitative research. At the stage of quantitative research, the researcher tested the effectiveness of learning with the 7E Learning Cycle model with ethno-mathematical nuances on students' problem-solving abilities through (1) the average similarity test; (2)

completeness test which includes classical completeness test (proportion) and average completeness test; and (3) the average difference test with the prerequisite test includes normality test and homogeneity test.

The significant values of the normality and homogeneity tests on the initial test of problem-solving abilities were 0.200> 0.05 and 0.664> 0.05, respectively, so it can be stated that the initial test data for problem-solving abilities came from a population that was normally distributed and homogeneous. In the average equality test, the value on the t-test equality of means is 0.957> 0.05, so it can be stated that the average initial problem-solving ability in the experimental class is the same as the initial problem-solving ability in the control class. The value on the classical completeness test is obtained by Z count 2.11 while Z table is 1.65 so that Z count> Z table, it can be stated that 75% of students in the class taught using the 7E Learning Cycle model nuanced classical ethnomatics complete. The average result of the problem-solving ability test in the experimental class is 80.33 with a standard deviation value of s = 7.34 and the number of students 33. The value on the average completeness test was obtained t = 8.08 while the t table was 1.70 so that it can be stated that the average problem-solving ability of students in the experimental class exceeds the KKM. The significant values of the normality and homogeneity tests on the test of problem-solving abilities were 0.195 > 0.05 and 0.996> 0.05, respectively, so it can be stated that the test data for problem-solving abilities came from a population that was normally distributed and homogeneous. The average problem-solving ability test results in the experimental and control classes were 80.33 and 65.34, respectively, with the variance being s12 = 53.91 and s12 = 56.42. The problem is obtained the combined standard deviation value of s = 1.84 with tcount = 8.14 while ttable 1.67 so that tcount> ttable, it can be stated that the average problem-solving ability of the experimental class is more than the average problem-solving ability of the control class.

After carrying out research and analyzing research data, it was found that (1) the learning equipment used in the experimental class had very good criteria; (2) learning in class using the 7E Learning Cycle model with ethno-mathematical nuances can achieve both classical and average completeness; (3) the average problem-solving ability in the class taught by the 7E Learning Cycle model with ethno-mathematical nuances is more than KKM; and (4) the average problem-solving ability of students in classes taught by the 7E Learning Cycle model with ethnomatematic nuances is more than the average problem-solving ability in classes taught using direct learning models. So, it can be concluded that learning with the 7E Learning Cycle model with ethno-mathematical nuances is effective.

The effectiveness of a lesson is an indicator of the success of learning that is carried out. Apart from the several factors above, the success of learning is also determined by the creativity of educators in developing learning. The high average problem-solving ability is a supporting fact that learning with the 7E Learning Cycle model with ethno-mathematical nuances is effective.

Learning Cycle is learning with a continuous inquiry method that is originally intended to improve students' intellectual development (Siribunnam & Tayraukham, 2009). Learning Cycle 7E is a learning model that applies constructivism in which knowledge is built from students' own knowledge. So that it increases the ability of student learning outcomes especially combined with meaningful ethnomatematic learning. This is according to the theory put forward by Vygotsky is the Zone of Proximal Development (ZPD). As quoted by Trianto (2007), Vygotsky states that the learning process will occur if children work or handle tasks that have not been learned, but these tasks are still within their reach, called ZPD, namely areas where the level of development is slightly above development. someone at this time. Vygotsky also explained one way that can improve the development of students' abilities, namely by scaffolding. Scaffolding means giving a large amount of assistance to a child during the early stages of learning and then the child takes over increasing responsibility as soon as he or she can do it.

Learning model of Learning Cycle 7E with ethno-mathematical nuances requires students to learn through concept discovery based on assignments adapted to cultural backgrounds Students are motivated to acquire new knowledge because the tasks carried out are oriented to the culture and the daily world of students, so they are challenged to solve problems that occur. exist in every learning activity. This explains that a series of student activities on the 7E Learning Cycle teaching materials developed encourages students to explore information in accordance with their cognitive structures to be constructed with new information to produce more meaningful learning as described in Ausubel's theory.

The effectiveness of the 7E Learning Cycle model with ethno-mathematical uances in this study is supported by the findings of several previous studies, including the results of research by Noor & Mulyono (2016) which states that the ability to solve problems through the 7E learning cycle reaches individual and classical completeness. In addition, research conducted by Siribunnam & Tayraukham (2009) shows that students who learn using the 7E Learning Cycle have higher analytical thinking skills, learning achievement, chemistry learning attitudes than students learning with conventional models. Likewise, research conducted by Widiastuti (2014) states that the average problem-solving ability of the experimental class through the 7E learning cycle model is higher than that of the control class.

The qualitative research was conducted to determine the description of students' mathematical problem-solving abilities based on their curiosity. Through the curiosity classification test using a curiosity inventory questionnaire instrument. After the test, 2 subjects were randomly selected for each EC and PC category. Based on the curiosity inventory questionnaire qualifications, there were 18 students in the EC category and 15 students in the PC category with a total number of students in the experimental class being 33 students. The analysis of EC subjects included weak EC (ECL) and Strong EC (ECK) subjects while the PC analysis included weak PC (PCL) and strong PC (PCK) subjects, each subject was analyzed qualitatively.

The analysis was carried out on two items, each of which was categorized as medium and difficult. The results of the problem-solving ability test obtained in problems 1 and 5 in accordance with Polya's problem-solving stage are shown in Figure 1.

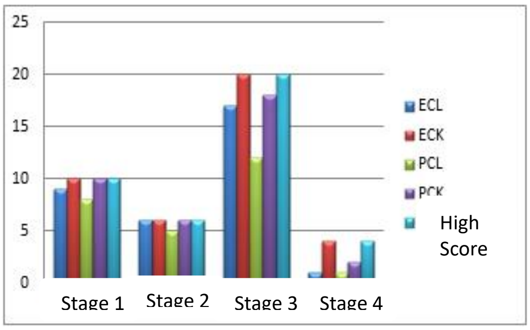

Figure 1. The results of the research subject's problem-solving ability

Figure 1 is the interpretation of the scores for each stage of problem solving in EC and PC subjects. Stage 1 is understanding the problem, stage 2 is planning for problem solving, stage 3 is implementing the problem-solving plan, and stage 4 is checking again. Based on the results of triangulation of job data and student interviews, it was found that the ECL subject was able to compile a problem-solving plan based on the facts given to the questions and sort information and solve problems but was unable to re-check the results of problem solving that had been compiled. An example of the results of ECL work in the problem-solving stage is shown in Figure 2.

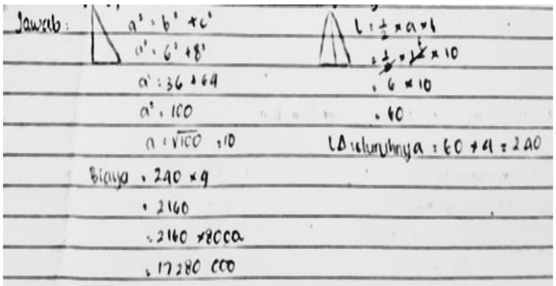

Figure 2. The ECL's work on problem solving stage 1

Based on Figure 2, the PCL subject performs calculations by looking for the unknown side, then uses the known side to find the area of the triangle which is then used to find the exact cost.

The ECK subject is able to do well at every stage including understanding the problem, planning for completion, implementing the completion plan to re-checking his work on each question according to the indicators. An example of the work of the ECK subject at the re-check problem 1 stage is shown in Figure 3.

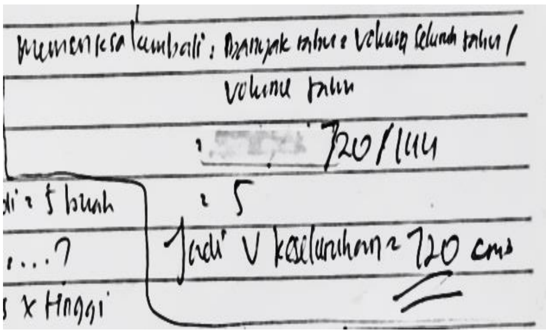

Figure 3. The ECK's work on problem re-checking stage 5

Based on Figure 3, it can be seen that at the rechecking stage, the ECK subject is able to check the correctness of the results of problem solving, to draw conclusions.

The PCL subject was less able to prepare problem-solving plans based on the facts given to the questions and sort the information, this resulted in the PCL subject being less able to solve the problem so that he was unable to re-examine the results of the problem solving that had been compiled. An example of the results of PCL work in the problem-solving stage is shown in Figure 4.

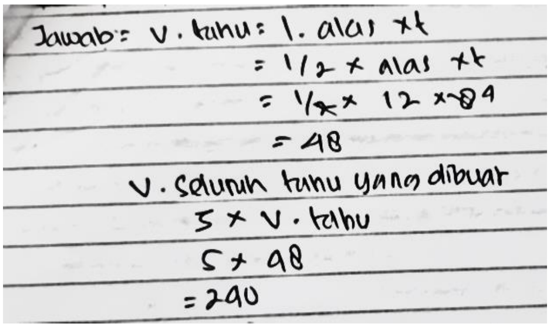

Figure 4. The PCL's work on problem solving stage 5

Based on Figure 4. PCL subjects performed calculations by writing the incomplete formula, in this case ½ x base x t base x t tofu then multiplied by the number of tofu, in this case it was not enough to write down the height of the tofu. So that the calculation results are not quite right.

PCK subjects were able to understand problems, plan solutions, to carry out plans very well and fulfill every indicator at each stage, but PCK subjects were less able to re-examine the results of solving problems that had been done. The results of PCK work at the stage of understanding the problem in question 1 are shown in Figure 5.

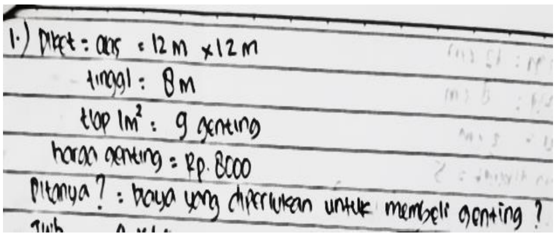

Figure 5. The PCK's work on the stage of understanding the problem

Based on Figure 5, it can be seen that the PCK subject is able to write down what is known, write down the things being asked to explain the sketch of the problem very well. The PCK job at the check-backstage is shown in Figure 6.

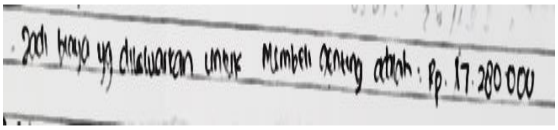

Figure 6. The PCK's work on the re-checking stage

At the rechecking stage, PCK subjects were only able to write conclusions without re-checking their answers. PCK subjects are less able to check the correctness of the work results and compile a problem-solving plan with different steps.

A summary of the results of the analysis of the problem-solving abilities of EC and PC subjects based on the Poya stages can be seen in Table 2

Table 2. The Mapping Analysis of EC and PC Subject of Probem Solving Abilities

Stage	Subjects	EC		PC	
		ECL	ECK	PCL	PCK
Understanding	1	✓	✓	✓	✓
Problem	5	✓	✓	✓	✓
Planning	1	✓	✓	✓	✓
Solving	5	✓	✓	O	✓
Doing	1	✓	✓	✓	✓
Panning	5	✓	✓	O	✓
Checking	1	X	✓	X	O
Re-checking	5	X	✓	X	X

Note: ✓ = Able; O=Quite Able.
X= Not Able

The ability of EC subjects at the problem understanding stage tends to be the same as the ability of PC subjects at the problem understanding stage. EC and PC subjects were able to write down what they knew, write down what was asked and explain a sketch of the problem. However, the EC subject is able to write things related to numbers and a deep understanding of calculations. This is as suggested by Litman (2008) which states that epistemic curiosity tends to motivate someone to acquire knowledge related to new ideas, eliminate information gaps, and solve intellectual problems. Have a curiosity towards abstract things to understand and process information. The PC subject had an overview of the problems related to the surrounding culture but did not really understand the problem in depth. This is in accordance with Berlyne (1954) who stated that perceptual curiosity is more associated with feelings that affect the environment, where their curiosity arises after they get external stimuli.

At the planning completion stage, EC Subjects tend to be able to develop problem-solving plans well. EC subjects are able to compose a problem-solving plan based on the facts provided and simplify problems using their own sentences. This is in line with the opinion of Litman (2008) that epistemic curiosity, especially epistemic specific, is the desire to seek knowledge or information that is directed to answer specific questions. Meanwhile, PC individuals tend to be less capable to capable. Some PC subjects were able to make general problem-solving plans as the facts contained in the questions, but some others were less able to make general problem-solving plans as the facts contained in the questions.

At the stage of implementing a problem-solving plan, the EC Subject is able to translate the problems given in the form of mathematical sentences, solve problems with predetermined strategies and take decisions and actions by determining and communicating conclusions appropriately. This is in accordance with research conducted by Litman & Mussel (2013). This is also in accordance with the characteristics of EC individuals having a desire to acquire new knowledge (for example, concepts, ideas, and facts) which are expected to stimulate intellectual interest (type-I) or eliminate an information deficiency condition (D-type). Type-I epistemic curiosity appears to be maximally activated when individuals recognize an opportunity to discover something really new, whereas D-type epistemic curiosity is optimally stimulated when people lack certain information, they want to incorporate into existing knowledge pools (Litman, 2012). Meanwhile, PC subjects tended to be from underprivileged to capable. PC subjects can translate a given problem in the form of mathematical sentences and write formulas to solve problems but are less able to calculate with appropriate algebraic manipulation to determine problem solving. This is in line with the opinion of Berlyne (1954) that perceptual curiosity is more associated with feelings that affect the environment, where their curiosity arises after they get external stimuli. Perceptual Curiosity tends to be weak in solving abstract problems and they are more challenged to find out information related to the environment.

At the re-checking stage, EC subjects tend to be less able to be able to recheck their work. The EC subject is able to check the correctness of his work and conclude a solution with the right answer. However, some of the EC subjects were less able to compile solutions to problems with different steps, while some others were unable to compile solutions to problems using different steps. PC subjects tend to be incapacitated. PC subjects are unable to recheck and write down conclusions from their work and tend not to be able to write conclusions with the right answers. The PC subject has not been able to compile a solution to the problem with different steps. This is in accordance with the nature of the PC which is more interested in visuals than abstracts. Collins (2004) who states that PC, has an interest and attention to perceptual stimulation, and motivates visual and sensory inspection. the PC subject is unable to expand on the problem-solving results obtained.

CONCLUSION

The qualitative analysis revealed the finding that in general, EC subjects had better problem-solving abilities than subjects with the PC category. Students with different curiosity will have different problem-solving abilities, therefore the teacher can analyze students' curiosity using a curiosity inventory questionnaire first in order to provide learning to students according to their respective needs.

Based on this research, students have a high interest in ethnomatematic objects. In order to build a good understanding, it is hoped that mathematics teaching materials will have ethno-mathematical nuances. Therefore, based on this research, it can be concluded that the problem-solving ability will be more optimal if it is built through the right design and learning scenario by paying attention to the curiosity aspects of each individual student.

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