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Analysis of Mathematical Reasoning Ability of Eight Grade on CORE Learning Model in terms of Thinking Style

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Abstract

This study aimed to determine the effectiveness of the CORE learning model toward students' mathematical reasoning ability and describe the students' mathematical reasoning ability through the application of the CORE learning model in terms of students' thinking styles. This study used a mixed method with a concurrent embedded strategy and posttest-only control group design. The population in this study were the eight grade students of SMP Negeri 2 Patebon. Samples were taken by using a simple random technique and obtained VIII A class as an experimental and VIII C as a control class. Subjects of this study were determined by using the purposive technique and obtained two students from each thinking style category. Data collection techniques in this study were a test, questionnaire, interview, and documentation. The quantitative data analysis of this study used both initial and research data. Research data analysis consists of individual completeness tests, classical completeness tests, average difference tests, and proportional difference tests. Before testing the effectiveness of learning, the prerequisite test is conducted first, namely the normality and homogeneity test. The qualitative data analysis technique was carried out by using qualitative descriptive methods, including data reduction, data display, and conclusion drawing. The results showed that (1) the implementation of the CORE learning model is effective towards students' mathematical reasoning ability; and (2) subject with concrete sequential have good ability in mathematical reasoning; subject with abstract sequential tends to be very good in mathematical reasoning ability; subject with concrete random tends to be good in mathematical reasoning ability; subject with abstract random tends to have the low ability in mathematical reasoning.

1. Introduction

Mathematics is one of the subjects that students must study. Ayal *et al.*, (2016) states that mathematics should be given to all students because it supply students with the ability to think logically, analytical, systematic, and creative. NCTM as cited in Siagian (2016) states that one of the objectives of learning mathematics is that students learn to reason mathematically.

Kusumawardani *et al.*, (2018) states that mathematical reasoning is not only a foundation for other standard, but also reasoning and mathematics have an inseperable connection. Reasoning is used when solving problems. While reasoning is understood and enhanced through learning mathematics. Wardhani (2010) defines reasoning as a thought process to draw conclusion or make a new true statement based on statement that have been proven before. According to NCTM as quoted by (Fonseca, 2018) mathematical reasoning is a habit of thinking that must be developed consistently in many contexts.

The indicators of mathematical reasoning ability in this study based on Wardhani (2010) which include: (1) filing for conjectures; (2) drawing conclusion, compiling proofs, giving a reason or proof to the truth of the solution; (3) performing mathematical manipulations; (4) drawing conclusions from a statement; (5)

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checking the validity of an argument: (6) find patterns or properties of mathematical phenomenon to make generalizations.

Based on the 2018 Program for International Student Assessment (PISA) result showed that Indonesia was rank 73 out of 79 in mathematical skill (OECD, 2019). This result tends to go down than the 2015 PISA Indonesia was rank 69 out of 76. From those result, it can be said that the mathematical skill of Indonesian students are still relatively low. Reasoning ability is one of mathematical skill required for students to master. The other fact found in field is that students still experience difficulties to solve the problem. This can be caused by the students who have not depth understood mathematical concept, the lack of learning motivation of students, passive students in learning process, and moreover learning process still using conventional learning models.

Optimizing students mathematical reasoning ability in solving mathematical problems requires appropriate learning model. One of the model that can be applied is the Connecting, Organizing, Reflecting, Extending (CORE) learning model. The CORE model provides students to discuss and interact with one another. The result of research by Curwen et al. (2010) stated that the CORE learning model emphasized the students to be able to construct their knowledge by connecting new knowledge and old knowledge and understanding the new knowledge in the discussion session (organizing), thinking about concepts that are being studied (reflecting), and expanding their knowledge during teaching-learning process (extending).

Thinking style according to Gregorc as quoted by DePorter & Hernacki (2008) is way of processing and organizing information. Different thinking style make the information that is accepted by the students are learned in different way, too, and this resulting in their way to solve problems (Lestanti et al., 2016; According to Gregorc as cited in (Sahatcija & Ferhataj, 2017), brain dominations are divided in two groups: perceptual ability and ordering ability. Perceptual ability deals with how an individual receives an information. While ordering ability deals with how a person arranges and uses information. Perceptual ability is divided into concrete (interpret information by five senses) and abstract (understanding ideas which cannot be seen). Ordering ability are divided into sequencial (linear) and random (nonlinear).

This study will use the Gregorc classification, which consist of concrete-sequential, abstract-sequential, concrete-random, and abstract-random. Toktarova & Panturova (2015) students who belong to the concrete-sequential manage information following step after step logical sequence, they prefer working within a solitary and structured environment, and following directions and procedures. Students belonging to the abstract-sequential prefer applying detailed analysis before making a decision and uses logic in order to solve problems. Students belonging to concrete-random prefer risk, experimenting, and use their intuition and solve problem independently. Students who belong to abstract-random prefer focusing on issues at hand, work in group activities, likes to listen to others and establish harmonious relationships with colleageues.

Based on the background that have been described, this study aims to: (1) determine the effectiveness of CORE learning model towards students' mathematical reasoning ability; and (2) describe the students' mathematical reasoning ability through the application of CORE learning model in terms of students' thinking styles.

2. Methods

The research method used in this study was mixed method. Mixed method is a research method that uses both quantitative and qualitative methods in combination to provide comprehensive, valid, reliable, and objective data in a study. The research method of this study was mixed method with concurrent embedded strategy. Concurrent embedded in mixed methods research is a strategy which both quantitative and qualitative methods data are collected simultaneously. A concurrent embedded has a primary methods that guide the project and a secondary methods that provide a supporting role in the procedure (Sugiyono, 2015).

Quantitative research was carried out to find out whether the CORE learning model effective towards mathematical reasoning ability of class VIII. While qualitative research was carried out to describe the students' mathematical reasoning ability through the application of CORE learning model in terms of students' thinking styles.

This study used Posttest Only Control Group Design. The population of this study were all students of eight grade in SMP Negeri 2 Patebon in the academic year of 2017/2018. The population in this study was taken based on the following considerations (1) the students get the material based on the same curriculum,

(2) the students who become object of this study sit at the same class level, and (3) the placement of the students is not based on rank.

The sample of this study determined by simple random sampling technique, namely, the sampling technique that was carried out without paying attention to the existing strata in the population (Sugiyono, 2015). There are two groups were chosen randomly. The first group, namely VIII A as an experimental class who were given treatment in the form of CORE learning model. The second group, namely VIII C as control class who were given treatment in the form of expository learning. After getting different treatment, both class were given posttest to know the students' mathematical reasoning ability.

Table 1. Posttest-Only Control Group Design

Class	Treatment	Posttest
Experiment	X	T
Control	-	T

Information:
T : Posttest of mathematical reasoning ability
X : CORE learning model

The research subjects of this study determined by purposive sampling technique. According to Sugiyono (2015), purposive sampling is a technique of sampling data sources with certain considerations. The research subject selected for qualitative research were eight subjects from the experimental class who had previously been given a thinking style questionnaire instrument. Students were grouped based on the result of the students' thinking styles questionnaire and categorized into four type of thinking styles, namely concrete-sequential, abstract-sequential, concrete-random, and abstract-random. From each category of thinking style, two students were chosen. The selected research subjects were then analysed their mathematical reasoning ability based on the result of posttest.

Data collection techniques in this study were test, questionnaire, interview, and documentation. Questionnaire was used to assess the students' thinking style which were concrete sequential, abstract sequential, concrete random, and abstract random. Interview was used to obtain the students' mathematical reasoning ability data in solving problems. Documentation was used to obtain data of the students in VIII A as an experimental class and VIII C as control class.

Quantitative data analysis technique was performed on the initial and research data. Initial data analysis consists of normality test, homogeneity test, and two means similarity test. While the research data analysis consists of hypothesis tests which are individual completeness test, classical completeness test, average difference test, and proportions difference test. Before testing the hypothesis, prerequisite test was carried out onto the research data including normality and homogeneity test. The qualitative data analysis technique was carried out by using qualitative descriptive methods including data reduction, data display, and conclusion drawing.

3. Results & Discussions

3.1. Result of Quantitative Analysis

3.1.1 Initial Data Analysis

Initial data obtained from the result of midterm test in the academic year of 2017/2018 of VIII A and VIII C. Initial data analysis consists of normality test, homogeneity test, and two means similarity test. The results of initial data analysis can be seen in Table 2.

Table 2. The Results of Initial Data Analysis

Test	Sig	α	Conclusion
Normality test	0.251	0.05	Normal distribution of data
Homogeneity test	0.934	0.05	Data homogeneous
Two means similarity test	0.271	0.05	The population come from the same condition

The analysis of normality using Kolmogorov-Smirnov test with a significant level of 5% indicate that the initial data are normally distributed and homogeneous (having the equal variances). The two means similarity test showed that there are no significant means difference between the two class. It can be concluded that both experimental and control class come from similar condition.

3.1.2 Research Data Analysis

Research data is the data of the test of mathematical reasoning ability posttest.

Table 3. The Results Of Mathematical Reasoning Ability Test

Class	N	Mean	Max	Min
Experiment	33	80.06	98	90
Control	32	75.15	55	55

Statistic test was carried out to test the effectiveness of the CORE learning model on the research data. Research data analysis consists of hypothesis I and hypothesis II test. Hypothesis I test in this study includes individual completeness test and classical completeness test. Hypothesis II test in this study includes average difference test and proportional difference test. Before testing the effectiveness of a learning, the prerequisite test is conducted first, namely the normality and homogeneity test using SPSS 20.0. Based on this test, the research data obtained from a population with normal distribution and also homogeneous.

The result of the research analysis can be described as follows:

- Individual Completeness Test
  Individual completeness test used a predetermined mastery learning. The mastery learning in this study is 75 from a scale of 0 to 100. To determine the average achievement, the right-hand t-test with α=0.05 was conducted. The result showed that t_{value} =3.510>t_{table} =1.694. Since t_{value}>t_{table}, then H_0 is rejected meaning that the average test result of students' mathematical reasoning ability using the CORE model reach the mastery learning.
- Classical Completeness Test
  Classical completeness test is carried out to measure the students' mathematical reasoning ability on the CORE learning model which the can achieve classical completeness where at least 75% of the total students meet the mastery learning. The test used one-sided proportion test (right) z-test. Based on the result, it is obtained that z_{value}=1.708>z_{table}=1.64. Since z_{value}>z_{table}, then H_0 is rejected meaning that the average test result of students' mathematical reasoning ability using the CORE model reach the classical completeness. Therefore it can be concluded that 75% of the students met the mastery learning.
- Average Difference Test
  Average difference test is carried out to determine whether the average of mathematical reasoning ability with the application of the CORE learning model was higher than the average of mathematical reasoning ability with the application of expository learning model. It used the t-test obtained t_{value} =2.378>t_{table} =1.6605. It was clear that t_{value}>t_{table} so that H_0 is rejected meaning that the average test result of students' mathematical reasoning ability on the CORE learning model was higher than the average of mathematical reasoning ability on expository learning model.
- Proportional Difference Test
  Proportional difference test was carried out to determine whether the proportion of students who completed the mathematical reasoning ability with the CORE learning model was higher than the proportion of students who completed the mathematical reasoning ability with the expository learning model. From the result obtained z_{value}=2.375>z_{table}=1.64. It was clear that z_{value}>z_{table}, then H_0 is

rejected meaning that the proportion of students' mathematical reasoning ability on the CORE learning model was higher than the average of mathematical reasoning ability on expository learning model.

Based on the analysis result above shows that the implementation of CORE learning model is effective towards mathematical reasoning ability. Ningsih *et* al., (2019) in her research explained that implementation of the CORE learning model provide the better mathematics' learning outcome than students who received conventional learning. Similarly, Anggraini *et al*., (2015) states that the result of implementing the CORE learning model has successfully reached the classical completeness and effective in achieving the mathematical problem solving ability.

Jacob as quoted by Putra & Mashuri (2016) states that the CORE learning model is one of the learning model based on constructivism which give students to be active during learning process. Curwen et al. (2010) reinforced that the use of the CORE model supports students in learning activities since each step students are encouraged to take a role in connecting their selves to learn (Connecting), organize the materials that have been obtained (Organizing), reflecting the material they have learned in class (Reflecting), and broaden students' knowledge (Extending). In addition, in the CORE learning model, students are required to interact actively with other students through group discussion. This is in line with the theory put forward by Piaget as quoted by Rifa'i & Anni (2011) that at the time of learning it is necessary to create an atmosphere that allows interactions between learning subjects. Therefore, the CORE learning model can be implemented in mathematics learning towards students' mathematical reasoning ability.

3.2. Result of The Thinking Style Grouping

The students were grouped based on thinking style category. This study used a questionnaire which was adopted from DePorter & Hernacki (2008). The questionnaire consist of 25 questions which had to be chosen by the students according to their respective conditions. The questionnaire was given to the experimental class. The data obtained from filling out the questionnaire were then analysed according to the thinking style questionnaire assessment guideline.

Based on analysis result of the questionnaire, there were 9 students with concrete sequential thinking style, 7 students with abstract sequential thinking style, 5 students with concrete random thinking style, and 8 students with abstract random thinking style. Students with two thinking styles also found in this study, which are 2 students with concrete sequential-concrete random, 1 student with concrete random-abstract random, and 1 student with abstract sequential-abstract random.

According to the result above, two research subjects were selected from each category. Then those research subjects is investigated further regarding mathematical reasoning ability among the students with concrete sequential, abstract sequential, concrete random, and abstract random thinking style. The research subject in this study were obtained as presented in Table 4.

Table 4. Research Subject

Category	Subjects
Concrete sequential	S-01
	S-02
Abstract sequential	S-03
	S-04
Concrete random	S-05
	S-06
Abstract random	S-07
	S-08

3.3 Mathematical Reasoning Ability in terms of Students' Thinking Style

The analysis of the mathematical reasoning ability on CORE learning model in terms of thinking style was carried out by analyzing the posttest results of mathematical reasoning ability and the results of interview.

This section showed a discussion of students' mathematical reasoning ability by comparing the posttest results of mathematical reasoning ability and the results of interview to obtain a description of students' mathematical reasoning ability based on thinking style. The research subject was selected based on the thinking style, namely concrete sequential, abstract sequential, concrete random, and abstract random thinking style.

3.3.1 Mathematical Reasoning Ability of Subjects Concrete Sequential

In this study, subject with concrete sequential thinking style is S-01 and S-02. Indicator of filing for conjecture can be met properly by the subjects. Even though S-01 sometimes did not write completely what being asked from the problem.

Indicator of drawing conclusion, compiling proofs, giving a reason or proof to the truth of the solution can be met properly by the subjects. Subjects also write the mathematical model of the problem systematically. This is in line with Tobias (2013) where students with concrete sequential work systematically.

Indicator of performing mathematical manipulation also can be met properly by the subjects. S-01 write the procedures with detailed and clear step but sometimes miscalculated. S-02 perform mathematical manipulation well. This result is in line with DePorter & Hernacki (2008: 128) which states that students with concrete sequential doing task step by step.

Indicator of drawing conclusion from a statement is fulfilled by the subjects. Subjects can find the solution from the problem well.

Indicator of checking the validity of an argument is not fulfilled by the subjects. S-01 do not check the solution he get, while S-02 check the solution but it is not yet correct.

Indicator of find patterns or properties of mathematical phenomenon to make generalizations can be fulfilled by the students, even though on some problem subjects did not write the conclusion in everyday sentence, but when asked in interview they can answer it easily. From the result, subjects with concrete sequential almost fulfill all indicators of mathematical reasoning ability except checking the validity of an argument. Therefore subject with concrete sequential have good ability in mathematical reasoning.

At the time of learning with the CORE model, the subjects with concrete sequential thinking style had a tendency when learning process was conducted they did not check their result and they liked to be guided when they had difficulties in solving problems. This is in line with DePorter & Hernacki (2008: 128) that the students with concrete sequential thinking style liked to have a particular instruction from teacher.

3.3.2 Mathematical Reasoning Ability of Subjects Abstract Sequential

In this study, subject with abstract sequential thinking style is S-03 and S-04. Indicator of filing for conjecture can be met properly by the subjects. Even though S-04 sometimes did not write completely what being asked from the problem.

Indicator of drawing conclusion, compiling proofs, giving a reason or proof to the truth of the solution can be met properly by the subjects. Subjects write the mathematical model of the problem systematically and with detailed step. Subjects understand and apply the mathematical model from the problem well. This is in line with Zollinger & Martinson (2010) which states that subjects with abstract sequential have a good ability in writing and drawing symbols.

Indicator of performing mathematical manipulation also can be met properly by the subjects. Subjects write the procedures with detailed and clear step but sometimes miscalculated. Subjects with abstract sequential did not have difficulties in solving the problems. This result is in line with DePorter & Hernacki (2008: 134) which states that students with abstract sequential tends to think and analyze information, and like to thinks logically, rational, and intellectual.

Indicator of drawing conclusion from a statement is fulfilled by the subjects. Subjects can find the solution from the problem well.

Indicator of checking the validity of an argument is fulfilled by the subjects. Subjects check the calculation that have been done by substituting the solution they get to one of the mathematical model.

Indicator of find patterns or properties of mathematical phenomenon to make generalizations can be fulfilled by the students. From the result, subjects with abstract sequential fulfill all indicators of mathematical reasoning ability. Therefore subject with abstract sequential tend to be very good in mathematical reasoning ability.

At the time of learning with the CORE model, the subjects with abstract sequential thinking style had a tendency when learning process was conducted they seemed able to pay attention to the material presented. This is in line with Tobias (2013) that the students with abstract sequential thinking style liked to learn something by observing in detail. They did not have difficulties when solving problems.

3.3.3 Mathematical Reasoning Ability of Subjects Concrete Random

In this study, subject with concrete random thinking style is S-05 and S-06. Indicator of filing for conjecture can be met properly by the subjects. Subjects write what is given and being asked from a problem in detail.

Indicator of drawing conclusion, compiling proofs, giving a reason or proof to the truth of the solution is not fulfilled by the subjects. Subjects can not construct mathematical model of the problem well. S-05 have not yet understood the mathematical model from the problem well. While S-06 did not write the mathematical model in the answer sheet and only write the definition of the variable she used. This is in line with Ma'rufi (2011) which states that subjects with concrete random hold on to reality, so that they have difficulties in constructing mathematical model of a problem.

Indicator of performing mathematical manipulation also is fulfilled by the subjects. Subjects write the procedures but sometimes miscalculated. Subjects with concrete random did not solve the problem according to the instruction and solve the problem with their own way. This result is in line with DePorter & Hernacki (2008: 130) which states that students with concrete random have a strong urge to find alternatives and solve problem with their own way. Subjects with concrete random also say that they tends to running out of time while solving problem. This is in line with the Ma'rufi's research (2011) which states that while solving problem, subject with concrete random thinking style tends to not care about time when focused on an interesting situation.

Indicator of drawing conclusion from a statement is fulfilled by the subjects. Subjects is quite capable to find the solution from the problem well.

Indicator of checking the validity of an argument is not fulfilled by the subjects. Subjects did not check the calculation that have been done step by step. This is in line with Lestanti's research (2016) which states that subjects with concrete random thinking style did not check their result with detailed and clear step to believe their answer.

Indicator of find patterns or properties of mathematical phenomenon to make generalizations can be fulfilled by the students. Subjects did not write the conclusion for some problems. But from triangulation, they can explain the conclusion of the problem well. From the result, subjects with concrete random thinking style fulfill four indicators of mathematical reasoning ability. Therefore subject with concrete random tends to be good in mathematical reasoning ability.

At the time of the interview, the subjects with with concrete random thinking style often ran out of time working on the problem and took trial error approach while solving problem. This is in accordance with DePorter & Hernacki (2008: 130) that concrete random thinking style tend not to care about the timing while facing an interesting situation.

3.3.4 Mathematical Reasoning Ability of Subjects Abstract Random

In this study, subject with concrete random thinking style is S-07 and S-08. Indicator of filing for conjecture can be met properly by the subjects. Subjects write what is given and being asked from a problem but not in detail.

Indicator of drawing conclusion, compiling proofs, giving a reason or proof to the truth of the solution is fulfilled by the subjects. Subjects construct mathematical model of the problem but not with detailed and clear step. This is in line with Tobias (2013: 25) which states that subjects with abstract random have difficulties in organizing task in detail.

Indicator of performing mathematical manipulation also is not fulfilled by the subjects. Subjects have not been able to solve the problems correctly. Subjects have difficulties in solving problems. It can be caused by the students have not yet understand the mathematical concept of the learning material. This result is in line with Lestanti's research (2016) which states that students with abstract random write the procedures, but could not solve the problems.

Indicator of drawing conclusion from a statement is not fulfilled by the subjects. Subjects could not the problems correctly, so that the solution obtained is not correct.

Indicator of checking the validity of an argument is not fulfilled by the subjects. Subjects did not check the calculation that have been done step by step.

Indicator of find patterns or properties of mathematical phenomenon to make generalizations is not fulfilled by the students. Subjects write the conclusion, but because the calculation is not correct then the conclusion obtained is wrong. From the result, subjects with abstract random only fulfill two indicators of mathematical reasoning ability. Therefore subject with abstract random tends to have low ability in mathematical reasoning.

In this study, the average of the mathematical reasoning test of subject with concrete sequential obtained 79,88. The average of the mathematical reasoning test of subject with abstract sequential obtained 83,28. The average of the mathematical reasoning test of subject with concrete random obtained 81,6. The average of the mathematical reasoning test of subject with abstract random obtained 74,62. This result showed that the average of the mathematical reasoning test of subject with abstract sequential is higher than all the other thinking style. This result is in line with Sutriningsih (2015) and Lestanti et al. (2016) which states that the average of the mathematical problem solving test is higher than all other thinking style.

When learning with the CORE model, the subjects with abstract random thinking style liked to interact with people through discussion, but they had a tendency to process information for long periods of time. This is consistent with Deporter & Hernacki (2008: 132) that one of the characteristics of the abstract random thinking style is absorbing ideas and information for long periods of time.

4. Conclusion

The conclusion obtained from this study are (1) the implementation of the CORE learning model is effective towards students' mathematical reasoning ability; and (2) subject with concrete sequential have good ability in mathematical reasoning; subject with abstract sequential tend to be very good in mathematical reasoning ability; subject with concrete random tends to be good in mathematical reasoning ability; subject with abstract random tends to have low ability in mathematical reasoning.

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