Mathematical Representation Ability and Mathematics Self Efficacy in CORE Learning Models with Open-Ended Approach

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Abstract

Mathematical representation ability is a cognitive ability that must be possessed by students. However, the reality on the field is in contrast to that. Students' mathematical representation ability are still relatively low, so special measures are needed to improve them. Therefore, the application of connecting-organizing-reflecting-extending (CORE) learning models with an open-ended approach is chosen as a particular action to improve mathematical representation ability. The purpose of this study is to compare the improvement and attainment of mathematical representation ability and self-efficacy mathematics between conventional, core, and core class students with an open-ended approach. This research is quasi-experiment research using a modified pretest-postest design. The population of this study is all grade X students in Pondok Melati Senior High School, Bekasi. The sample of this study was students of Grade X of Sandikta High School and Nasional I High School who were taken in a cluster random sampling. The data collection techniques used are test and non-test techniques. Data analysis is conducted using the One Way Anova test. Based on data analysis, it is shown that: (1) there are significant differences in the improvement and attainment of mathematical representation ability between conventional, core, and core class students with an open-ended approach; and (2) there are significant differences in self-efficacy mathematics attainment between conventional, core, and core students with an open-ended approach.

Abstrak

Kemampuan representasi matematis merupakan kemampuan kognitif yang harus dimiliki oleh siswa. Namun, kenyataan di lapangan bertolak belakang dengan hal tersebut. Kemampuan representasi matematis siswa masih tergolong rendah, sehingga diperlukan tindakan khusus untuk meningkatkannya. Oleh karena itu, pengaplikasian model pembelajaran *Connecting-Organizing-Reflecting-Extending* (CORE) dengan pendekatan *open ended* dipilih sebagai tindakan khusus untuk meningkatkan kemampuan representasi matematis. Tujuan penelitian ini adalah untuk membandingkan peningkatan dan pencapaian kemampuan representasi matematis dan *mathematics self efficacy* antara siswa kelas konvensional, core, dan core dengan pendekatan *open ended*. Penelitian ini merupakan penelitian kuasi eksperimen dengan menggunakan *pretest-postest design* yang dimodifikasi. Populasi penelitian ini adalah seluruh siswa kelas X di SMA Kecamatan Pondok Melati, Bekasi. Sampel penelitian ini adalah siswa kelas X SMA Sandikta dan SMA Nasional I yang diambil secara *cluster random sampling*. Teknik pengumpulan data yang digunakan adalah Teknik tes dan non tes. Analisis data dilakukan dengan menggunakan uji Anova Satu Jalur. Berdasarkan analisis data, ditunjukkan bahwa: (1) terdapat perbedaan yang signifikan pada peningkatan dan pencapaian kemampuan representasi matematis antara siswa kelas konvensional, core, dan core dengan pendekatan *open ended*; dan (2) terdapat perbedaan yang signifikan pada pencapaian *mathematics self efficacy* antara siswa kelas konvensional, core, dan core dengan pendekatan *open ended*.

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INTRODUCTION

Five abilities can be developed through the objectives of mathematical learning, namely mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connections, and mathematical representation (Surya *et al.*, 2013). Mathematical representation ability are an essential ability to use in solving mathematical problems. The mathematical representation ability is the ability to represent mathematical expressions into other forms that can be used to create problem solutions (Bossé, Adu-Gyamfi and Cheetham, 2011; Zarkasyi, 2015). However, some research shows that students' mathematical representation ability are still low. Minarni, Napitupulu and Husein (2016) research revealed that students' ability to represent essay questions is still relatively low. Besides, Sari, Darhim and Rosjanuardi (2018) examined students' errors in mathematical representation tests. The study results showed that students made mistakes in solving problems involving arithmetic symbols that are about concepts related to characters and applying other mathematical concepts. Thus, students' mathematical representation ability still need special attention and action for them to be improved.

The development of a student's cognitive abilities is also accompanied by the development of the student's affective ability. One of the effective skills that can be measured development in mathematics learning in mathematics self-efficacy. Alldred (2013) and Li (2012) stated that self-efficacy could affect students' learning achievement. Causapin (2012) also says that self-efficacy mathematics refers to the belief in students' ability to learn and succeed in math lessons. But the phenomenon that occurs in the world of education, especially mathematics, students often have difficulty working on math problems. The study from Sarabi and Abdul Gafoor (2017) said that students' difficulty in using mathematical elements led to students' reduced motivation in learning mathematics, thus impacting the student's self-efficacy mathematics. It shows that attention is still needed to develop self-efficacy mathematics in a student.

Based on the results of interviews with students of grade X in Pondok Melati senior high school, most students have difficulty in solving math problems related to mathematical representation. Students also stated that students are still less confident in completing math problems or not confident in expressing their opinions. This can be seen from the student's study results in the previous material. Besides, the observations also show that the learning done by teachers still does not lead to the development of mathematical representation ability and less stimulating the growth of self-efficacy mathematics students.

Mathematical representation ability and self-efficacy can improve with an appropriate learning model, including a core learning model. The CORE learning model is a learning model that can organize the knowledge that students have and rethink the concepts that have been learned. Based on Beladina, Suyitno and Kusni, (2013) and Zarkasyi (2015), there are four stages in CORE learning, namely (1) connecting information that has been possessed and recently learned related to mathematical concepts or interdisciplinary with daily life (Connecting), (2) organizing ideas or ideas to understand materials (Organizing), (3) rethinking, deepening, and digging information based on existing sources (Reflecting), and (4) developing, expanding, finding, and using information obtained to solve a problem (Extending).

Muizaddin and Santoso (2016) said that core learning models positively affect students' cognitive learning outcomes. Because this learning model has several advantages, namely training students to discuss and work together, students can work on a problem with a common purpose, and students are more active and creative in the learning process. Core learning models can be applied by combining an open-ended approach. According to Shimada and Becker (in Fatah *et al.*, 2016), the open-ended approach provides more knowledge, discovery, recognizing, and solving problems. It is because, in this approach, issues are set with different methods and more than one solution.

The excellence of the core learning model with the open-ended approach is beneficial for students' problem-solving processes. Problem-solving is a significant element of mathematics. Students will be more comfortable to solve the problems then the students must be able to understand and represent the problems faced in the form of mathematics. If the student can understand and represent a problem well, they will have no difficulty solving a problem. So indirectly, students will have high motivation in learning mathematics. Thus, mathematics self-efficacy in students will grow and develop well. Therefore in core learning models with the open-ended approach is considered capable of improving mathematical representation capabilities and developing self-efficacy mathematics.

Based on the above explanation, this study's problem is whether there are differences in the improvement and attainment of mathematical representation ability and self-efficacy mathematics between students who obtain conventional learning (lectures), CORE, and CORE with an open-ended approach. So it can be explained that the purpose of this study is to find out the differences in improvement and attainment of mathematical representation capabilities and self efficacy mathematics between students who acquire conventional learning (lectures), CORE, and CORE with an open-ended approach.

Research related to core model learning has been widely conducted by researchers, including Nur, Hobri and Suharto (2014) and Hariyanto (2017). Nur, Hobri and Suharto (2014) research examined the development of mathematical learning tools in core learning models with contextual approaches. The research has not been oriented towards students' mathematical thinking abilities and open-ended approaches. Hariyanto (2017) research examines the application of CORE learning models to improve students' mathematical communication ability. This means the type of ability measured is different from this study. Besides, there was no discussion of improving students' affective abilities in the application of core learner models.

RESEARCH METHODS

This research is quasi-experiment research using a modified pretest-postest design. In this study, three samples will be selected to get different treatment, namely, experiment class 1 getting CORE learning, experiment class 2 getting CORE learning with an open-ended approach, and control class getting conventional learning. Before the study, all three categories were given pre-response, namely pretest of mathematical representation ability and self-efficacy mathematics scale to know both classes' results before being given treatment. After getting treatment, all three categories were given post-response, namely the postest mathematical representation capability and self-efficacy mathematics scale, to know the authorship of learning models that have been implemented towards mathematical representation capabilities and mathematics self-efficacy.

The population of this study is all grade X students in Pondok Melati Senior High School, Bekasi. While the sample used is grade X students of Sandikta High School as many as two classes and Sma Nasional I as many as one class. The sampling technique used is cluster random sampling.

The data collection techniques used in this study consist of test and non-test procedures. The test technique measures the ability of the student's mathematical representation, while the non-test technique measures the scale of the student's self-efficacy mathematics.

Based on the techniques used, the data obtained from this study is in the form of quantitative data. The data is the data of the test results of mathematical representation capabilities and the scale of mathematics self-efficacy. Data analysis was conducted using the One Direction Anova statistical test to see differences in the three sample groups' ability improvement after getting different learning.

RESULTS AND DISCUSSIONS

This research aims to determine the differences in the improvement and attainment of mathematical representation ability and self-efficacy mathematics between students who acquire conventional learning (lectures), CORE, and CORE with an open-ended approach. The improvement and achievement of mathematical representation capabilities can be seen from the test scores of mathematical representation abilities at the beginning and end of learning. For mathematics, a self-efficacy questionnaire is also given at the beginning and end of the study. Still, the results' analysis is only seen as an achievement because this research is done in a relatively short time.

The data generated from this study are data pretest and postest of mathematical representation capabilities, normalized gain data (N-gain) mathematical representation capabilities, and data from self-efficacy mathematics questionnaires. Here is a description of the results of this study.

Mathematical Representation Capabilities

The pretest and posttest results of mathematical representation ability are obtained from the number of student scores on each item of the test question given to the student. Furthermore, it can be determined the N-gain of the ability of mathematical representation. Descriptive statistical summary of data pretest, posttest, and N-gain mathematical representation capabilities can be viewed in table 1.

In Table 1, can be seen that the average score of mathematical representation ability obtained by conventional, Core, and core class students with an open-ended approach is different. There is a difference in the average increase between the three classes. This is evident in the following image.

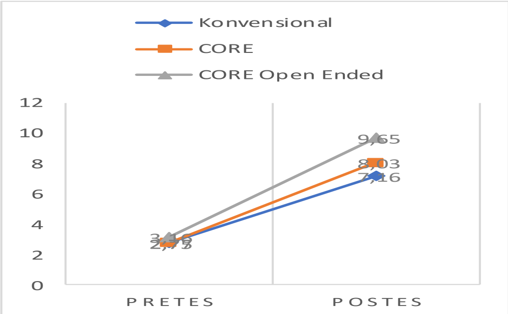

Figure 1. Average Improvement Graph Mathematical Representation Capabilities

Figure 1 shows that the average ability of the mathematical representation of students who acquire Core learning with an open-ended approach is higher than that of students with Core and conventional learning. Besides, the average ability of mathematical representation of students with Core learning is higher than in students with conventional learning.

The results of the One Way Anova test calculation on the posttest score of mathematical representation ability between conventional classes, cores, and cores with an open-ended approach are displayed in the following table.

Table 2. ANOVA Results from Postes Score Mathematical Representation Capabilities

F	Sig.	Conclusion
5,100	0,008	Reject H_0

The results in table 2 show that the value of significance obtained is smaller than α=0.05, which is 0.008. So it can be concluded that Ho was rejected, meaning there was a difference in the achievement of students' mathematical representation ability in all three classes. Therefore, a post hoc test needs to be conducted to determine which of these classes differs significantly. The following is a summary of the results of the post hoc test.

Table 3. Summary of Post Hoc Test Scores Postes Students' Mathematical Representation Capabilities

Hypothesis	Average Difference	Sig.	Conclusion
Konvensional* Core	0,877	0,547	Receive H_0
Konvensional* Core Open Ended	2,489	0,009	Reject H_0
Core*Core Open Ended	1,612	0,139	Receive H_0

Based on the table above, it can be concluded that there is a significant achievement difference between conventional classes and core classes with an open-ended approach. This is seen from the value of significance obtained is 0.009 or smaller than α=0.05, so Ho is rejected. Whereas between conventional classes and core classes and between core classes and core classes with an open-ended approach, the value of significance obtained is 0.547 and 0.139 (greater than α=0.05). In other words, there is no significant difference in achievement between conventional and Core classes and between core and core classes with an open-ended approach.
To determine the difference in mathematical representation capability between conventional classes, cores, and cores with an open-ended approach, the Kruskal-Wallis test was conducted on the N-gain score with the following calculation results.

Table 4. Kruskal-Wallis Results from N-gain Score Mathematical Representation Capabilities

Chi Square	Sig.	Kesimpulan
10,174	0,006	Reject H_0

The result in table 4 indicates that the value of significance obtained is 0.006. The grade is smaller than the level of significance of α=0.05, so it can be concluded that Ho was rejected, or there was a significant difference between the improved mathematical representation capabilities of conventional, Core, and core students with an open-ended approach. A follow-up test is required to see the significant difference between the three classes' enhanced mathematical representation capabilities by conducting an average difference test on each

Table 1. Descriptive Statistics Mathematical Representation Capabilities

Statistical Data	Conventional			Core			Core Open Ended		
	Pretest	Postest	N-gain	Pretest	Postest	N-gain	Pretest	Postest	N-gain
n	32	32	32	30	30	30	31	31	31
Mean	2,75	7,16	0,36	2,77	8,03	0,46	3,16	9,65	0,56
SD	2	2,41	0,16	2,37	3,53	0,22	1,9	3,37	0,25
Ideal Maximum Score = 15, Ideal N-gain Score = 1									

class pair. The average difference test used in this hypothesis test is the t-test and Mann Whitney test. The following is a summary of the results of the follow-up test.

Table 5. Summary of Advanced Test Results of N-gain Score Mathematical Representation Capabilities

Hypothesis	Average Difference	T	Z	Sig.	Conclusion
Konvensional*Core	0,101	2,065	-	0,044	Reject H_0
Konvensional*Core Open Ended	0,199	-	-3,200	0,001	Reject H_0
Core*Core Open Ended	0,098	1,632	-	0,108	Receive H_0

Based on the table above, the value of significance obtained from the increased difference test in conventional and Core classes is 0.044. This means that Ho is rejected, and it can be concluded that the increase in mathematical representation capabilities in conventional classes and core classes differs significantly. Similarly, for testing differences in upgrades in conventional and Core classes with an open-ended approach that resulted in a significance value of 0.001, smaller than the significance level of α=0.05. This suggests that the difference in students' increased ability of mathematical representation between conventional classes and core classes with an open-ended approach is significantly different. In contrast, testing the average difference in representation capability between core and core classes with an open-ended approach is not significantly different. This is because the value of significance obtained is 0.108 or greater than the significance of α=0.05, causing H0 to be rejected.

Analysis of posttest and N-gain data on the mathematical representation capabilities of students who acquire core learning with an open-ended approach shows that achievement and improvement differ significantly from students who achieve conventional and core learning. It can be said that the achievement and improvement are better than both classes. It can be due to differences in the types of problems given to students. Giving problems to conventional classrooms tends to refer to exercises and handbooks used by teachers and students. For core learning, the problem is more mathematical. As for core learning classes with an open-ended approach, the problems provided are authentic and closer to students' lives. The provision of issues in the open-ended approach can offer more knowledge and training for students in solving problems with various methods to represent the problem well. The open-ended approach can develop the student's thought process to not focus on one solution only (Kadarisma, 2018). However, students are more geared towards having an open mindset in solving problems. Herdiman (2017); Hidayat and Sariningsih (2018) also stated that learning with an open-ended approach makes students more active and passionate in solving problems. Students can explore the knowledge they have to achieve their desired goals.

Core learning has a positive effect on improving mathematical representation capabilities. Core learning consists of four stages, namely connecting, organizing, reflecting, and extending. In core learning, students are trained to construct new knowledge by reconnecting information that has been owned and learned. Then students discuss an idea in groups by engaging their creativity in solving the given problem. Core learning trains students to solve problems in discussion and requires students to be more active and creative in learning (Beladina, Suyitno and Kusni, 2013; Sofiarum, Supandi and Setyawati, 2020). Nur, Hobri and Suharto (2014) and Hariyanto (2017) also stated that core learning uses discussion to activate students' reasoning and construct ideas independently in solving shared problems. It leads to improved mathematical representation ability of students who learn with better core learning models than students who study with conventional learning models.

Mathematics Self Efficacy

The mathematics self-efficacy reviewed in this study is the difference between classes that acquire conventional, Core, and core learning with an open-ended approach. The measurement of mathematics self-efficacy at the beginning of the study aims to see the similarities of mathematics self-efficacy students have in all three classes. Here is a description of the preliminary and final data results of mathematics self-efficacy.

Table 6. Descriptive Statistics Mathematics Self Efficacy

Statistical Data	Conventional		CORE		CORE Open Ended	
	Pre	Final	Pre	Final	Pre	Final
n	32	32	30	30	31	31
X_{min}	41	46	42	50	41	50
X_{max}	61	68	59	69	70	71

Mean	49,44	55,88	50	57,97	54,84	61,45

To saw the final three data of mathematics self-efficacy differ significantly or not, and the statistical test results are presented as follows.

Table 7. Kruskal-Wallis Results from Mathematics Self Efficacy Score Rating

Chi Square	Sig.	Kesimpulan
9,352	0,009	Reject H_0

The result in table 7 indicates that the value of significance obtained is 0.009. The value is smaller than the level of significance of α=0.05, so it can be concluded that Ho is rejected, meaning there is a significant difference between the achievement of mathematics self-efficacy of conventional, Core, and core students with an open-ended approach. To saw the significant difference between the achievement of mathematics self-efficacy of the three classes, it is necessary to conduct follow-up tests by testing each class pair's average differences. The average difference test used in this hypothesis test is the Mann Whitney test. The following is a summary of the results of the follow-up test.

Table 8. Summary of Advanced Test Results from Mathematics Self Efficacy Score Rating

Hypothesis	Mann-Whitney U	Z	Sig.	Conclusion
Konvensional*Core	388,000	-1,299	0,194	Receive H_0
Konvensional*Core Open Ended	287,500	-2,871	0,004	Reject H_0
Core*Core Open Ended	326,000	-2,009	0,045	Reject H_0

Based on the table above, it appears that the achievement of mathematics self-efficacy of students between conventional and Core classes is not a significant difference. This is because the value of significance obtained between the two classes is greater than the level of significance α=0.05 so that H0 is accepted. It can also be seen in table 6, the average final score of mathematics self-efficacy in conventional and Core classes is 55.88 and 57.97. The two values are not much different, i.e., the difference only reaches 2.09. But overall, mathematics self-efficacy in both classes improved. This happens because the conventional and core learning process is implemented in both classes, and students have the same opportunity to express opinions. Conventional learning is no longer teacher-centered, but students are allowed to have discussions with other students so that students' self-efficacy in both classes can develop along with the learning done.

Another conclusion that can be seen in table 8 is the achievement of mathematics self-efficacy students between conventional and Core classes with an open-ended approach and between core and core classes with an open-ended approach indicating that H0 is rejected. The value of significance obtained in succession is 0.004 and 0.045. It means that students' attainment of self-efficacy mathematics between conventional and Core classes with an open-ended approach makes a significant difference. Similarly, students' achievement of self-efficacy mathematics between core and core classes with an open-ended approach also differs significantly. In general, it can be said that mathematics self-efficacy students who acquire core learning with an open-ended approach are better than students of conventional and core learning classes.

Core learning with an open-ended approach requires students to be active during learning. Students must also have a discussion process with their group to gain a new understanding. So that self-confidence in students will grow and develop well due to the very supportive learning process. Fatimah (2020) also stated that the role of discussion in core learning could improve students' knowledge, develop logical and reflective thinking ability, to develop students' self-efficacy attitudes. Besides, learning with an open-ended approach makes students more open if they find different solving problems. Learning with an open-ended approach allows students to develop ideas and exchange ideas in groups until they find the final solution (Setiawan and Harta, 2014; Luksiana and Purwaningrum, 2018). Thus, mathematics self-efficacy in students can grow and develop through core learning with an open-ended approach.

CONCLUSION

Based on the results of this study it can be concluded that: 1) achievement of the ability of mathematical representation of students between conventional classes and core classes does not differ significantly, 2) achievement of the ability of mathematical representation of students between conventional classes and core classes with a significantly different open ended approach, 3) achievement of the ability of mathematical representation of students between core and core classes with an open ended approach does not differ significantly , 4) increase the ability of mathematical representation of students between conventional classes and core classes differ significantly, 5) increase the ability of mathematical representation of students between conventional classes and core classes with significantly different open ended approaches, 6) improvement of students' mathematical representation ability between core classes and core classes with an open ended approach does not differ significantly, 7) the achievement of mathematics self efficacy of students between conventional classes and core classes does not differ significantly , 8) achievement of mathematics self efficacy students between conventional classes and core classes with significantly different open ended approaches, and 9) achievement of mathematics self efficacy students between core class and core class with significantly different open ended approach.

The implications of applying Core and core learning models with an open-ended approach. Both can improve students' mathematical representation ability and can develop self-efficacy mathematics.

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