International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 11, Issue 9
September, 2024
Pages: 401-411

The Effect of the PMRI Approach with STAD on the Conceptual Understanding Ability, Numeracy Ability, and Mathematical Disposition

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http://dx.doi.org/10.18415/ijmmu.v11i9.6186

Abstract

Conceptual understanding, numeracy ability, and mathematical disposition are a skill that students need, because having these three skills, students are able to solve various problems in everyday life. The Indonesian Realistic Mathematics Education (PMRI) approach with the setting of Student Teams Achievement Division (STAD) is used to improve students' conceptual understanding, numeracy ability, and mathematical dispositions. This study aims to describe the effect of implementing the PMRI approach with STAD settings on students' conceptual understanding, numeracy ability, and mathematical dispositions. This research is a quasi-experimental study with a pretest- posttest non-equivalent group design, with two class groups. Experimental class receiving treatment in the form of the PMRI approach with STAD, meanwhile control class receiving treatment conventional approach. Data collection techniques included tests consisting of pretest and posttest assessments of students' conceptual understanding and numeracy ability, as well as pre-nontest and post-nontest assessments of students' mathematical disposition. Hypothesis testing was conducted a t-test for two independent samples. The research results show that learning using the PMRI approach with the STAD setting is influential in terms of students' conceptual understanding, numeracy ability, and students' mathematical disposition.

Keywords: *Students' Mathematical Disposition; Numeracy Skills; Conceptual Understanding; Indonesian Realistic Mathematics Education; Student Teams Achievement Division*

Introduction

Education is something that is very necessary as one of the important factors to advance a nation and country. Because through good and quality education, new and useful things will be obtained which are used as provisions to create superior and quality human resources. (Sinarsih et al., 2021). According to Suwarsono, one of the important things that must be improved in education is students' ability in mathematics, because mathematics is a knowledge that will definitely be encountered in everyday life, mathematics is used in developing knowledge and technology and by having good mathematical skills, students will reason critically, actively, and carefully in solving problems in everyday life. (Rahayu & Kusuma, 2019).

Conceptual understanding ability have an important role to hook mathematics with various other knowledge fields. Various type problem in knowledge need existence ability in conceptual understanding for solve and complete the problem (Han et al., 2017). Numeracy ability is ability and capability in use

various type related numbers and symbols with mathematics for solve problem in various type context daily life and analyze information displayed in various form (graph, table, etc.) then use interpretation results analysis for predict and take decision (Han et al., 2017). Disposition is tendencies possessed by students in behave confidently, behave persistent, have curiosity, and think flexible consciously, regularly, and voluntarily to achieve a desired goal (Katz, 1993).

The importance of conceptual understanding ability, numeracy ability, and disposition mathematics student not in line with quality of conceptual understanding and capabilities actual numeration. Based on PISA results show that Indonesia obtained score 366 points, which is a fairly low score when compared to the international average of 472 points. (OECD, 2023). PISA results show low ability students in Indonesia in mastery of conceptual understanding ability as well as solve non-routine problems. Low mathematical disposition in schools is characterized by when students are given questions with increasing levels of difficulty, students tend to give up easily and do not want to work on the questions. Students do not show any strong interest when participating in the mathematics learning process.

To increase conceptual understanding ability, numeracy ability, and disposition mathematics student, a learning process is needed that is able to increase the effectiveness of learning, such as increasing student engagement, providing learning processes that aim to stimulate cognitive activities, and encouraging students to discuss and share. One of an approach that requires innovation and existence teacher creativity to make student play a role active in the learning process is Indonesian Realistic Mathematics Education (PMRI). Another important factor in the learning process is selection of learning models. Learning models cooperative type Student Teams Achievement Division (STAD) can changing the learning process from teacher centered become student centered which provides student with the ability to think logically, analytically, systematically, critically and creatively as well as the ability to work together. This result in line with research conducted by Mashuri et al., (2020) stating that learning model Student Teams Achievement Division (STAD) is effective when juxtaposed with RME approach. In this study, the influence of learning using a combination of the RME approach and the STAD model was compared with classes with conventional learning (teacher centered).

This study aims to convey data and see the influence of the PMRI approach with STAD settings on the conceptual understanding ability, numeracy ability, and mathematical disposition of junior high school students.

Method

This study uses quantitative approach with type study quasi experiment. Examination model use pre-test, post-test, pre-nontest, and post-nontest. In general, there are several stages of research, in the first stage, students try to work on pre-tests and pre-nontests to obtain an overview of students' conceptual understanding abilities, numeracy abilities, and initial mathematical dispositions. The second stage, students follow the learning process using the PMRI approach with STAD settings and learning using a conventional approach. In the third stage, students were given another test to see the influence of the PMRI approach with STAD settings on the development of students' conceptual understanding abilities, numeracy abilities, and mathematical dispositions. Next, the final stage is drawing conclusions.

The technique used when taking samples is purposive sampling. Purposive sampling technique is a technique for determining samples by considering certain things. This study involved students of class VII-A as the control class and class VII-E as the experimental class with each class consisting of 30 students. This study was conducted at SMP Negeri 1 Pleret, Bantul, Special Region of Yogyakarta.

In the first step, the teacher divides into several small groups with different levels of academic ability, gender, and race. The second step is that the teacher provides contextual problems with many

ways to solve them. The third step is that each group discusses how to solve the contextual problems given. At this step, a horizontal mathematization process occurs, namely the process of reasoning from the real world into mathematical symbols, as well as vertical mathematization, namely when searching for and finding conceptual relationships in order to solve the contextual problems given. The fourth step is the teacher gives a quiz to each student, with the team results used to determine which team gets the highest points. The fifth step is the teacher gives an award to the group that gets the highest points. The last step is the teacher and students conclude the material that has been studied.

Data were collected using test and non-test techniques. Pre-test and post-test to measure conceptual understanding ability with 10 multiple-choice questions, 5 complex multiple-choice questions, and 3 essay questions. To measure numeracy ability, 4 essay questions were given, while to measure mathematical disposition, 28 statements were given with answer choices of strongly agree (SS), agree (S), doubtful (RR), disagree (TS), and strongly disagree (STS). Before being used, the question instrument was tested for validity first, namely validated by competent experts in the field of mathematics. The grid of the conceptual understanding ability instrument used can be seen in Table 1.

Table 1. Grid about the conceptual understanding ability

No	Indicator	Question Items
1	Restating a concept	6,10,14
2	Identifying objects with certain characteristics that are owned by the object	1,11, 16,17
3	Mentioning examples of existing concepts and those that are not included in the examples	2,7,16
4	Connecting new knowledge with previously known knowledge	4.8, 15.18
5	Presenting geometric concepts in various forms of mathematical representation	3.5, 13.17
6	Applying geometric concepts and certain procedures in solving problems related to other disciplines in everyday life	9,12,18

The grid of the numeracy ability instrument used can be seen in Table 2.

Table 2. Grid about the question of numeracy ability

No	Indicator	Question Items
1	Students are able to utilize various numbers and symbols related to basic mathematics to solve various everyday problems	1,2,3,4
2	Students are able to analyze data presented in various formats or forms	1,2,3,4
3	Students are able to interpret the results of the analysis with the aim of predicting and making the right decisions related to problems in everyday life	1,2,3,4

The grid of the mathematical disposition instrument used can be seen in Table 3.

Table 3. Grid about the questionnaire of mathematics disposition

No	Aspect	Indicator	Item
1	Having self-confidence	• Demonstrate self-confidence in solving problems given. • Demonstrate self-confidence in the process of learning mathematics.	1,2,3, 4,5,6,7
2	Persistence and	• Demonstrate perseverance in completing tasks or mathematical problems given.	8,9,10, 11,12,

	perseverance	• Demonstrate persistence and never give up in solving a given mathematical problem.	13.14
3	Having interest and curiosity	• Demonstrate strong dedication in learning mathematics. • Demonstrate curiosity about mathematics, including the material that has been studied, is being studied, and will be studied.	15,16, 17,18, 19,20,21
4	Flexibility	• Demonstrate a flexible attitude in investigating ideas related to solving a mathematical problem. • Accept and deal with rejection from others.	22.23 24.25
5	Appreciation	Appreciate mathematics in everyday life and in other fields of knowledge.	26,27,28

The instruments used have also gone through validity and reliability analysis. The data in this study were analyzed descriptively with the aim of measuring the effect of the application of the PMRI approach with STAD settings on the ability to understand concepts, numeracy ability and mathematical dispositions of class VII students of SMP Negeri 1 Pleret, Bantul. The statistical technique as a prerequisite test is the normality test. While the hypothesis was tested using the t-test.

Results and Discussion

This research was conducted at SMP Negeri 1 Pleret using 30 students in class VII-E who implemented PMRI approach with STAD settings and 30 students in class VII-A who implemented conventional learning. The implementation was carried out for 5 meetings. Before starting the research, the validity and reliability of the instruments to be used were first tested. After that, at the beginning of the research, a pre-test and pre-nontest were given to determine the students' conceptual understanding ability, numeracy ability, and initial mathematical disposition, while at the end a post-test and post-nontest were given to determine the students' conceptual understanding ability, numeracy ability, and mathematical disposition after being given treatment.

A. Data processing

1. Descriptive Analysis

The data analyzed using SPSS so that the data that has been tabulated in Excel can be directly transferred to the t-test statistical formula. The data on the results of the conceptual understanding ability are shown in Table 4.

Table 4. Description of the results of conceptual understanding abilities

	Class Group			
	PMRI approach with STAD setting		Conventional approach	
Description	*Pre-test*	*Post-test*	*Pre-test*	*Post-test*
Number of Students	30	30	30	30
Average	40.08	67.20	41.97	43.48
Maximum Value	70.45	93.18	61.36	81.82
Minimum Value	15.91	36.36	15.91	11.36
Standard Deviation	13.82	14.73	11.71	18.43

Data on numeracy ability results is shown in Table 5.

Table 5. Description of numeracy ability results

Description	Class Group			
	PMRI approach with STAD setting		Conventional approach	
	Pre-test	*Post-test*	*Pre-test*	*Post-test*
Number of Students	30	30	30	30
Average	34.91	69.26	38.06	44.26
Maximum Value	66.67	100	72.22	77.78
Minimum Value	2.78	38.89	0	0
Standard Deviation	18.19	15.83	14.15	20.77

The mathematical disposition results data are shown in Table 6.

Table 6. Description of the results of mathematical disposition

Description	Class Group			
	PMRI approach with STAD setting		Conventional approach	
	Pre-test	*Post-test*	*Pre-test*	*Post-test*
Number of Students	30	30	30	30
Average	100.17	104.77	96.63	95.87
Maximum Value	11	132	123	120
Minimum Value	76	84	78	73
Standard Deviation	9.68	12.31	10.10	13.23

From the analysis in the table above, it aims to test the influence of the PMRI approach with the STAD setting that has been used during learning. From the three tables above, it shows an increase in the pre-test and post-test values as well as pre-nontest and post-nontest so that it can be seen that there are differences in the ability to understand concepts, numeracy abilities, and mathematical disposition before and after learning that applies the PMRI approach with the STAD setting.

2.Normality Test

All data has been declared valid and reliable, then a normality test is carried out. Whether or not the distribution of data is normal can be known from this test. The Shapiro-Wilk test was chosen to determine the distribution of data, with the provision that if the significance result is greater than 0.05 then the data is normally distributed, but if the significance result is less than 0.05 it means the data is not normally distributed. This test is based on the hypothesis, namely H_0 (Distribution in normal data) and H_1 (Distribution in non-normal data). The results of the normality test can be seen in Table 7.

Table 7. Results of normality test

Tests of Normality

		Shapiro Wilk		
	Class	Statistics	df	Sig.
Conceptual Understanding Ability	Experiment	.968	30	.485
	Control	.976	30	.723
Numeracy Ability	Experiment	.946	30	.136
	Control	.957	30	.259
Mathematical Disposition	Experiment	.937	30	.073
	Control	.965	30	.412

Based on Table 7, it can be seen that the significance value exceeds 0.05, that is 0.485; 0.723; 0.136; 0.259; 0.73, 0.412, so H_0 is accepted while H_1 is rejected. Based on these results, it can be said that the data distribution in this study has run normally.

3. Further Testing

The t-test was conducted to find out more about which learning approach has a more significant influence compared to other learning approaches on conceptual understanding, numeracy, and mathematical disposition. The test was conducted to find out whether PMRI with STAD settings has an influence on students' conceptual understanding, numeracy, and mathematical disposition or not. In this study, the t-test was conducted using SPSS version 24. As a basis for decision making, it can be seen through its significance value, that is if the significance value is < 0.05 and the t_{count} value > t_{table} value, it has an influence, and if the significance value is > 0.05 and the t_{count} value < t_{table} value, it has no influence. The statistical hypothesis model used in this study is determined as follows.

H_0: There is an influence of the PMRI approach with STAD settings on students' conceptual understanding, numeracy, and mathematical disposition.

H_1: There is no influence of PMRI with STAD settings on students' conceptual understanding, numeracy skills, and mathematical disposition. The results of the t-test can be seen in Table 8.

Table 8. t-Test Results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Conceptual Understanding Ability	Equal variances assumed	2.241	.140	5.505	58	.000	10,433	1,895	6,640	14,227
	Equal variances not assumed			5.505	55,303	.000	10,433	1,895	6,636	14,231
Numeracy Ability	Equal variances assumed	1,370	.247	5.243	58	.000	9,000	1,717	5,564	12,436
	Equal variances not assumed			5.243	54,188	.000	9,000	1,717	5,559	12,441
Mathematical Disposition	Equal variances assumed	.570	.454	2,697	58	.009	8.900	3,300	2.295	15,505
	Equal variances not assumed			2,697	57,697	.009	8.900	3,300	2.294	15,506

Based on table 8, the Sig. (2-tailed) value or significance value is 0.00 < 0, so H_0 is accepted and H_1 is rejected. This shows that the application of PMRI with STAD settings has a significant effect on students' conceptual understanding, numeracy ability, and mathematical disposition. The results of the pre-test and post-test are used as a reference in making descriptions. The initial activity carried out before starting the research is to first conduct a validity and reliability test on the research instruments needed during learning. In carrying out the test, all the questions tested were declared valid and reliable.

The data obtained from the study showed the influence of PMRI with STAD settings on students' conceptual understanding, numeracy ability, and mathematical disposition. Furthermore, the t-test (independent sample t-test) is the next step in testing the hypothesis.

The t-test is a step that can be taken in an effort to find significant differences in the three variables. The results of the t-test or independent sample t-test show that the Sig. (2-tailed) value or significance value is 0.00. In accordance with the basis for making decisions on the comparison of significance values and t_{count} values, it can be concluded that $0.00 < 0.05$ then H_0 is accepted and H_1 is rejected, which means that there is an influence of the Indonesian Realistic Mathematics Education (PMRI) approach with STAD settings on students' conceptual understanding abilities, numeracy abilities, and mathematical dispositions.

Based on the data from the quantitative descriptive analysis, the average pre-test score for students' conceptual understanding ability showed a fairly low number, that is 40.08 in the experimental class group and 41.97 in the control class group, this means that students at this school still lack mastery of concepts, especially in geometry material. This could be caused by a learning approach or learning model that is less effective, students are not given adequate practice questions, or students feel confused in applying a concept in a different context.

Based on the results of the average post-test value of the conceptual understanding ability in the class using the PMRI approach with the STAD setting, which is 67.20, it is greater than the average post-test value in the class using the conventional approach, which is 43.48 with a difference of 23.72. So it can be concluded that the class using the PMRI approach with the STAD setting is more influential than the class using the conventional approach based on the results of the average post-test value. Based on the results of further testing (poshoc) using the independent sample t-test, the t_{count} value = $5.505 > t_{table}$ = 2.000 with a sig value of $0.000 < 0.05$, then H_0 is rejected or it can be concluded that the realistic Indonesian mathematics education learning approach with the student team achievement division setting provides influential results compared to the conventional approach on students' conceptual understanding abilities, especially in geometry material.

Learning using the PMRI approach with STAD settings emphasizes the use of real-world contexts that are relevant and close to students' daily lives and then relates them to geometric concepts. In geometry materials, especially flat-sided geometric shapes, students can understand concepts through objects and situations that they encounter every day such as the shape of a classroom, the shape of an aquarium, the shape of food packaging, or other flat-sided geometric shapes that are close to students' lives. This makes the concept of geometry more concrete and easier to understand.

PMRI approach, problems are given in stages, starting from simple to more complex problems, so that students understand the basic concepts first before moving on to more complex concepts, the application of the PMRI approach can have a positive influence on students' conceptual understanding abilities, this is in line with research conducted by Arnida Sari and Suci Yuniati which states that the RME approach has a positive influence on students' mathematical concept understanding abilities (A. Sari & Yuniati, 2018). PMRI learning emphasizes on everyday life that is already known to students, so that students can easily and actively complete learning because the basic concepts in learning are in accordance with their knowledge. While STAD is a cooperative learning model where students learn together with heterogeneous groups, each group member ensures that each team member understands the material well through re-explanation and joint practice. Deka Purnama Sari, N. Nurochmad, H. Haryadi, and S. Siturjim, who stated that STAD learning can significantly improve students' mathematical understanding abilities and student responses also look quite good, students are very enthusiastic and communicative in the learning process (D. P. Sari et al., 2016).

Learning model cooperative type STAD with RME approach can increase understanding mathematical ability (Mashuri et al., 2020). This is because it allows students to understand complex and

abstract things, students are given the opportunity to be actively involved in responding to contextual problems given by the teacher by being given the freedom to find various alternative answers, students are given the opportunity to solve problems given by the teacher in their own way with the group, and are given the opportunity to compare and discuss the answers obtained. The STAD learning model combined with the RME approach can improve students' mathematical concept understanding abilities. (Nurhayati & Hartono, 2017).

The average pre-test score on students' numeracy ability also showed a low number, that is 34.91 in the experimental class group and 38.08 in the control class group. This shows that students still find it difficult to use basic mathematical operations (addition, subtraction, multiplication, and division) to solve the problems given, difficulty in reading and interpreting data presented in various forms such as story and picture problems, and difficulty in using data and analyzing it to make predictions related to the materials needed to form a geometric shape. Another contributing factor is the lack of practice questions related to basic mathematics such as addition, subtraction, multiplication, and division with complex calculations.

Based on the results of the average post-test value of numeracy ability in the class using the PMRI approach with STAD settings, which is 69.26, it is greater than the average post-test value in the class using the conventional approach, which is 44.26 with a difference of 25. So it can be concluded that the class using the PMRI approach with STAD settings has an effect compared to the class using the conventional approach based on the results of the average post-test value. Based on the results of further testing (poshoc) using the independent sample t-test, the results of the $t_{count} = 5.243 > t_{table} = 2.000$ with a sig value of $0.000 < 0.05$, then H_0 is rejected or it can be concluded that the realistic Indonesian mathematics education learning approach with the student team achievement division setting provides results that have an effect compared to the conventional approach on students' numeracy abilities.

The use of the PMRI approach with STAD settings provides an experience that is close to students' lives. Learning uses real examples and problems as an effort to ensure that numeracy is not boring and easy for students to understand. Numeracy is very important in daily life (Jain & Rogers, 2019). The relationship between numeracy ability and mathematical ability seen from the concept and implementation, numeracy and mathematics have a close relationship. Numeracy ability refer to the need to use and apply various mathematical knowledge in everyday life. PMRI learning combined with STAD can help students develop students' numeracy ability, because students are involved in solving mathematical problems related to everyday life and applying mathematical concepts in real situations. (Najwa, 2018).

The PMRI approach focuses on real-life situations that help students relate difficult mathematical concepts to concrete everyday experiences. Understanding the basics of these concepts can help students develop more effective ways of solving problems that require good numeracy ability and applying their mathematical knowledge in new and unusual situations. The PMRI approach with STAD settings provides opportunities for students to work alone or in small groups. In line with research conducted by Fakhri Fakhruddin Anwar, which states that the cooperative learning model type STAD can improve students' numeracy ability and knowledge, this is because by using STAD learning students do not depend on teachers so that students can think for themselves and exchange ideas and thoughts with their peers. (Anwar, 2023).

Learning using the PMRI approach with STAD settings can support all indicators of numeracy ability, that is students are able to utilize various numbers and symbols related to basic mathematics to solve various everyday problems; students are able to analyze data presented in various formats or forms; and students are able to interpret the results of the analysis with the aim of predicting and making the right decisions related to problems in everyday life.

The average pre-nontest score on students' mathematical disposition in the experimental class group was 100.17 and in the control class group 96.63, this was caused by several factors. First, it is possible that students do not yet have confidence in solving the given mathematical problems. Second, students easily give up when they have difficulty solving the given mathematical problems. In addition, the learning approach used in class, the support of teachers and parents, and social environmental factors can also play a role in shaping students' mathematical dispositions.

Based on the results of the average post-nontest value of mathematical disposition in the class using the PMRI approach with STAD settings, which is 104.77, it is greater than the average post-nontest value in the class using the conventional approach, which is 95.87 with a difference of 8.90. So it can be concluded that the class using the PMRI approach with STAD settings is more influential than the class using the conventional approach based on the results of the average post-nontest value. Based on the results of further testing (poshoc) using the independent sample t-test, the value of $t_{count} = 2.697 > t_{table} = 2.000$ with a sig value of $0.009 < 0.05$, then H_0 is rejected or it can be concluded that the Indonesian realistic mathematics education learning approach with the student team achievement division setting provides influential results compared to the conventional approach on students' mathematical disposition

Mathematical disposition is the tendency of students to think and behave positively towards mathematics (Diningrum et al., 2018). The PMRI approach encourages students to develop a positive disposition towards mathematics, because this approach uses the relevance of mathematics in everyday life. When students work in STAD groups, they can share ideas, discuss, and feel a sense of shared success. This can increase students' motivation and interest in mathematics, which are part of a positive mathematical disposition. Learning using the PMRI approach with STAD settings applied to experimental classes can have a significant influence on improving students' mathematical dispositions. The results of this study are in line with the findings of previous studies conducted by Novitasari (2016), with the research results there was an increase in mathematical disposition in students who were given the PMRI approach compared to students who were given conventional learning.

The presentation of material with the PMRI approach in the experimental class presents mathematics in a real-world context, allowing students to understand mathematical concepts better compared to the more theoretical formal mathematical approach in the control class. In the PMRI approach, the focus is on questions that do not only have one way of solving, this creates opportunities for students to combine existing knowledge with new concepts that students learn. Therefore, by using the PMRI approach, students can combine previous knowledge with new concepts as an interrelated unit. By using the PMRI approach, students can gain an understanding of mathematical concepts by relating them to situations and problems in everyday life. (Yetim Karaca & Özkaya, 2017). The PMRI approach, when used as a way to present material, can be combined with the STAD cooperative learning model as a framework for organizing students. Shila Majid, Gunarhadi, and Riyadi in their research, found that the STAD learning model with the RME approach provided good learning outcomes, because students who had high learning activities had better mathematics learning outcomes than students with medium and low learning activities (Ardiyani & Gunarhadi, 2018). Therefore, the use of the STAD learning model integrated with PMRI has a positive impact on students' conceptual understanding, numeracy ability, and mathematical dispositions. Learning with STAD integrated with PMRI helps students to better understand geometric concepts and develop better numeracy ability, as well as encourage students' mathematical dispositions.

Conclusion

Based on the results of the research and data processing, it can be concluded that there is an influence of the Indonesian Realistic Mathematics Education (PMRI) approach with the STAD setting on students' conceptual understanding, numeracy ability, and mathematical dispositions. In relation to this

research, there are several suggestions, including the Indonesian Realistic Mathematics Education (PMRI) approach with the STAD setting can be used in learning to train and increase students' conceptual understanding, numeracy ability, and mathematical dispositions. For further research, the current research can be modified or developed with similar research so that it can improve students' conceptual understanding, numeracy ability, and mathematical dispositions. Learning can also be packaged with more exciting activities, so as to increase enthusiasm and students can be actively involved in learning. In addition, group division must also be carried out evenly between students with good and less good cognitive abilities.

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