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The Effect of Realistic Mathematics Education (RME) Approach Assisted by Traditional Game of Congklak on Higher Order Thinking Ability and Math Anxiety of Junior High School Students and Math Anxiety of Junior High School Students

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Abstract

This study aims to describe whether or not there is an effect of the Realistic Mathematics Education (RME) approach assisted by the traditional game of congklak in learning mathematics on higher order thinking skills and math anxiety of students. The type of research used is quasi experimental research with a quantitative approach. The population in this study were all VIII grade students at one of the State Junior High Schools in Sleman Regency in the 2024/2025 school year. The research sample was taken through purposive sampling technique with a sample size of 64 students consisting of two classes. The instruments used to collect data were observation sheet of learning implementation, pretest and posttest of higher order thinking ability, and math anxiety questionnaire. The questions of higher order thinking skills and math anxiety questionnaire were declared valid by two expert lecturers. Data analysis techniques used were descriptive statistics and inferential statistics (confidence interval estimation using 95% confidence level). The test statistic used in this research is Hotelling's T2 test to determine the difference in the average vector for two independent samples, then continued with the t test for each research variable. The results showed that there was an effect of Realistic Mathematics Education (RME) approach assisted by traditional game of congklak on higher order thinking ability and math anxiety of junior high school students.

Keywords: *Realistic Mathematics Education Approach; Traditional Game of Congklak; Higher Order Thinking Skills; Math Anxiety*

Introduction

Education in the era of Society 5.0 demands a learning system that is not only oriented towards knowledge transfer, but also on character development, higher order thinking skills, and adaptability to technological and social changes (OECD, 2018). Education in this context requires to be able to produce individuals who are not only proficient in academic aspects, but also have the ability to think critically, creatively, communicatively, and collaboratively or known as 4C skills (Kemendikbud, 2018). Mathematics, as a science that demands logical and systematic reasoning, has a significant contribution in achieving these competencies (NCTM, 2020; Kilpatrick, Swafford, & Findell, 2001).

However, the results of the Program for International Student Assessment (PISA) survey in 2022 show that Indonesian students' ability to solve mathematics problems that require higher order thinking skills is still relatively low, with a mathematics score of only 366, 106 points below the global average (OECD, 2023, p.29). Only 5% of Indonesian students are rated as proficient in creative thinking, while more than 50% of students are in the low performance category (OECD, 2023). These results indicate that students' higher order thinking skills (HOTS) are still a serious problem in mathematics learning.

In addition to low HOTS, students are also faced with math anxiety, which is a feeling of fear and tension when dealing with mathematical activities (Ashcraft, 2002). This anxiety negatively affects students' working memory and performance in solving math problems, especially those that are complex and analytical (Ramirez et al., 2013). Math anxiety can even cause students to stay away from math lessons and have an impact on low learning achievement (Setyaningsih & Abadi, 2018). Research shows that ineffective teaching methods, lack of variety, and minimal interactivity are one of the main causes of math anxiety (Arem, 2010; Greenwood in Thijsse, 2002).

To overcome these problems, the Realistic Mathematics Education (RME) approach is considered relevant and effective. This approach was developed by Freudenthal and emphasizes that mathematics is a human activity that starts from a real context (Wijaya, 2012). RME encourages students to build mathematical concepts through meaningful exploration of contextual situations, as well as develop higher-order thinking skills in an interactive and fun learning atmosphere (Ma'arif & Sutarni, 2023). Context in RME can be obtained from local culture, including traditional games, which have the potential to foster students' mathematical skills and character (Orey & Rosa, 2008; Astuti, 2020).

One form of cultural context that is rich in educational value is the game of congklak. This game has been shown to contribute to improving children's numeracy skills and concepts of mathematical operations (Khasanah et al., 2023; Adiastuty et al., 2022). Furthermore, the value of fun contained in traditional games is believed to reduce students' anxiety levels towards mathematics (Dharmamulya, 2008), while supporting meaningful learning according to the Pancasila Student Profile (Murti, 2023).

However, there are still limited studies that specifically examine the integration of the RME approach assisted by the traditional game of congklak in learning mathematics, especially on the material of chance. Based on this, this study aims to describe the effect of Realistic Mathematics Education approach assisted by traditional game of congklak on higher order thinking ability and math anxiety of junior high school students. This study is expected to provide an empirical contribution to the development of contextual, fun, and responsive mathematics learning approaches to the challenges of 21st century education.

Methods

This study is a quasi-experimental research with a quantitative approach that aims to describe whether or not there is an effect of the Realistic Mathematics Education (RME) approach assisted by traditional congklak games in mathematics learning on students' higher order thinking skills and math anxiety. The quasi experiment design used in this research is non-equavilent control group design. Higher order thinking ability and math anxiety in experimental and control classes were evaluated twice through the implementation of pretest and posttest. The pretest was conducted before the treatment was given with the aim of assessing the level of higher order thinking skills and math anxiety of students before getting the treatment of the application of the RME approach assisted by the traditional game of congklak in the experimental class and the Scientific approach in the control class. After the treatment was given, both class groups were measured again using a posttest. The posttest was used to evaluate whether there was a difference in the level of higher order thinking skills and math anxiety after the treatment.

The population of this study were all VIII grade students at SMP Negeri 2 Depok. The research sample was determined using purposive sampling technique so as to obtain 64 students consisting of two classes with each class consisting of 32 students. The two classes that became the research samples were

VIII D class as the experimental class and VIII C class as the control class. The research instruments used to collect data were the learning implementation observation sheet, pretest and posttest of higher order thinking skills, and the math anxiety questionnaire . The questions of higher order thinking skills and math anxiety questionnaire were declared valid by two expert lecturers. The pretest and posttest questions each consisted of 3 questions with the material given, namely Opportunities and math anxiety questionnaire consisting of 20 statements.

The data analysis technique of this research was carried out with several tests consisting of:

1. Content validity test of higher order thinking ability instrument and math anxiety questionnaire tested by two expert lecturers and declared valid.
2. Construct validity test with confirmatory factor analysis technique and obtained correlation between items of all factors is 0.866 for higher order thinking ability variable and 0.725 for math anxiety variable. $\geq 0,3$
3. Reliability test using Cronbach's Alpha formula, and the results obtained are 0.866 for the higher order thinking ability variable and 0.725 for the math anxiety variable.

Furthermore, the assumption test is carried out, namely the normality test and the homogeneity test. After the assumption test is fulfilled, then the hypothesis test can be done using Hotteling's T^2test.

Results and Discussion

Results

The following is a description of the data of pretest and posttest results of higher order thinking ability and math anxiety of students.

Table 1. Descriptive Statistics of Higher Order Thinking Ability Test

Descriptive	Experiment Class		Control Class	
	Pre-test	Post-test	Pre-test	Post-test
Number of students	32	32	32	32
Average	29,94	80,75	28,76	66,67
Standard Deviation	3,12	3,29	3,39	3,60
Ideal minimum value	0	0	0	0
Ideal maximum score	100	100	100	100
Minimum score	23,19	75,36	21,74	59,42
Maximum value	36,23	86,96	34,78	73,91

Based on Table 1 above, it can be seen that the higher order thinking skills in the experimental and control classes have increased after being given treatment. The average increase was 50.81 for the experimental class and 37.91 for the control class. The increase in the average post-test score of higher order thinking skills in the class that applied the Realistic Mathematics Education approach aided by the traditional game of congklak was greater than the increase in the average post-test score of higher order thinking skills in the class that applied the Scientific approach. By comparing the average posttest score of higher order thinking skills, it can be concluded that the higher order thinking skills of experimental class students are higher than those of control class students.

Table 2. Descriptive Statistics of Math Anxiety Questionnaire

Descriptive	Experimental Class		Control Class	
	Pre-test	Post-test	Pre-test	Post-test
Number of students	32	32	32	32
Average	62,75	49,31	62,12	57,56
Standard Deviation	5,23	2,19	4,48	2,86
Ideal minimum value	20	20	20	20
Ideal maximum score	100	100	100	100
Minimum score	55	45	53	52
Maximum score	76	54	72	62

Based on Table 2 above, it can be seen that the decrease in the average score of the math anxiety questionnaire for the experimental class is 13.44 with an initial average score of 62.75 and a final average score of 49.31. The decrease in the average score of math anxiety questionnaire for the control class is 4.56 with the average score of the initial questionnaire of 62.12 and the average score of the final questionnaire of 57.56. The average score of math anxiety questionnaire in the experimental class and control class decreased after the treatment. The decrease in the average score of the final questionnaire of math anxiety in the class that applied the Realistic Mathematics Education approach assisted by the traditional game of congklak was greater than the decrease in the average score of the final questionnaire of math anxiety in the class that applied the Scientific approach. By comparing the average score of the final questionnaire, it can be concluded that the math anxiety of experimental class students is lower than the control class students.

The mean difference test results of the pretest of high level thinking ability and math anxiety of both classes are presented in Table 3.

Table 3. Multivariate Test Results of Pretest Data

Hotelling's T^2	**p-value**	**Decision**
2,3869	0,316	$H_0$is accepted

Based on Table 3, it is obtained that the p-value is 0.316, the value is greater than 0.05. This means that at a significance level of 0.05, there is no difference in the population mean pretest scores of the experimental and control classes, so it can be concluded that the two classes have relatively similar initial conditions.

The results of the posttest mean difference test of high level thinking ability and math anxiety of both classes are presented in Table 4.

Table 4. Multivariate Test Results of Posttest Data

Hotelling's T^2	**p-value**	**Decision**
354,77	0,000	$H_0$is rejected

Based on Table 4, it is obtained that the p-value is 0.000, the value is less than 0.05. This means that at a significance level of 0.05, there is a difference in the population mean posttest scores of the experimental and control classes.

Based on the explanation above, it can be concluded that there is an effect of the application of Realistic Mathematics Education approach with the help of traditional game of congklak on higher order thinking ability and math anxiety of students. Thus, the first hypothesis has been answered. Then, to answer the next hypothesis, further tests were carried out with the Two Independent Sample t-Test test to determine the effect on each variable of higher order thinking ability and math anxiety of students. The results of the Two Independent Sample t-Test are presented in Table 5 below.

Table 5. Two Independent Sample t-Test Test Results

Variable	t	p-value
Higher Level Thinking Ability	16,304	0,000
Math Anxiety	-12,948	0,000

Based on Table 5, the p-value or significance for higher order thinking ability is 0.000, because the p-value <0.05 then H_0 is rejected. So that at a significance level of 0.05 it can be concluded that the population average score of higher order thinking skills between the experimental class and the control class is different. The experimental group has a statistically higher average. Based on Table 5 also obtained for math anxiety obtained a p-value of 0.000, because the p-value <0.05 then H_0 is rejected. So that at a significance level of 0.05 it can be concluded that the population average math anxiety score between the experimental class and the control class is different. The experimental group has a statistically lower average than the control class.

Discussion

1. The Effect of Learning with Realistic Mathematics Education (RME) Approach Assisted by Traditional Game Congklak on Students' Higher Order Thinking Ability and Math Anxiety

Based on the results of the pretest of higher order thinking skills and math anxiety of students, it is obtained that there is no difference in the average of the two variables in the class group, namely the class group using the Realistic Mathematics Education approach assisted by traditional games of congklak and the class group using the Scientific approach. This is indicated by the results of the Hotelling's T^2 test which shows a p-value of 0.316> 0.05 so that H_0 is accepted, which means that the ability or initial condition of students before being given treatment is the same. Based on the statistical results of the Hotelling's T^2 test after treatment, it shows a p-value of 0.000 < 0.05, which means that H_0 is rejected, so there is a difference in the average posttest of the experimental class and the control class, which means that there is an effect of the Realistic Mathematics Education approach assisted by traditional games of congklak and the scientific approach on higher order thinking skills and math anxiety.

This finding is in line with the results of several recent studies. Romlah (2022) stated that RME is able to encourage students to think more critically and logically through real-life contexts that are close to them. In line with that, Naufal and Alshaye (2023) found that students taught with the RME approach showed significant improvement in higher order thinking skills based on the results of PISA-based evaluation. In a systematic review conducted by Munawaroh and Waluya (2024), it was explained that RME consistently strengthens critical thinking skills because it requires students to understand problems deeply, not just memorize formulas. In addition, the use of traditional games such as congklak in learning can enrich the realistic context in RME, while providing a fun and cognitively challenging learning atmosphere.

On the other hand, the RME approach also contributes positively in reducing math anxiety. Komala and Monariska (2023) revealed that through RME, students feel more confident because the material is presented in a context that they understand, thus reducing the psychological pressure that usually arises in learning mathematics. Sugiarti et al. (2025) asserted that this approach not only improves problem-solving skills, but also significantly reduces students' anxiety levels about math. The scientific approach, which emphasizes the processes of observation, reasoning, and communication, also plays a role in building self-confidence and reducing anxiety because students are more active in the learning process.

Overall, the application of the RME approach with the traditional game of congklak and the scientific approach creates contextualized, fun and participatory learning. This has great potential to improve higher order thinking skills while reducing students' math anxiety.

2. The Effect of Learning with Realistic Mathematics Education (RME) Approach Assisted by Traditional Game of Congklak on Higher Order Thinking Skills

Based on the results of the analysis of the two independent sample t-test, the p-value of 0.000 <0.05 was obtained, so it can be concluded that learning with the Realistic Mathematics Education approach with the help of traditional games and the scientific approach has an effect on students' higher order thinking skills. With the average score of experimental class posttests higher than the control class. It can be seen that the utilization of the traditional game of congklak in learning opportunities contributes positively to students' higher order thinking skills. The congklak game encourages students to analyze game situations, evaluate strategies, and can create new ideas in the game. During the learning process, students are not only involved cognitively, but also actively discussing. In the context of Opportunity material, the activity of playing congklak requires students to consider the possible results of each experiment, so they indirectly develop analytical thinking skills. In addition, through discussion activities, students are invited to evaluate the results of the experiment and asked to give their opinions, this reflects the evaluative aspect of higher order thinking skills. When students are asked to design game ideas, they are involved in the process of creating new ideas, which reflects the creating aspect.

The posttest results of students' higher order thinking skills consisted of six indicators of higher order thinking skills. The first indicator is identifying the main components, in this case students identify the sample point, sample space, event, and probability of an event. The following is a snippet of one of the posttest questions on higher order thinking skills.

1. Dalam sebuah permainan, sebuah kotak berisi 6 kartu hijau, 3 kartu merah, 7 kartu putih, dan sebuah koin.
   a. Sebutkan komponen-komponen utama yang ada dalam permainan ini (kartu dan koin)

Figure 1. Snapshot of the First Indicator Posttest Question

The following are some student answers in the experimental class for one of the questions listed in Figure 1 above:

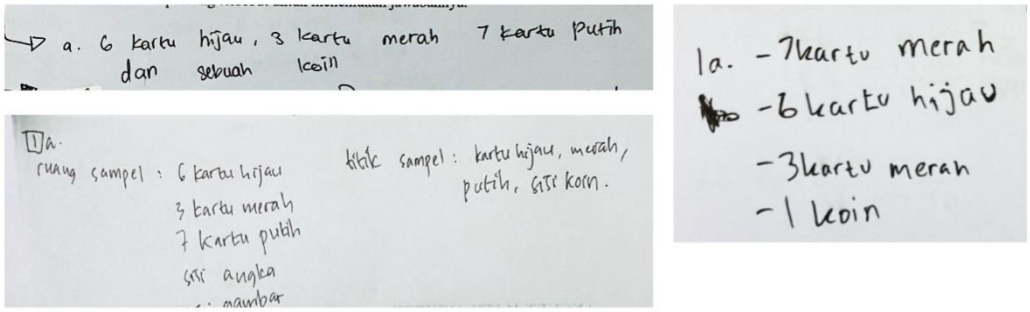

Figure 2. Some Student Answers

In Figure 2, it can be seen that students are able to mention that there are two objects in the game, namely cards and coins. However, only some were able to explicitly identify the complete sample space. The sample points for picking up cards include 16 possibilities (6 green, 3 red, 7 white), while for coins there are two possibilities (numbers and pictures). The ability to mention events, for example "taking a

red card and getting the number side of the coin," is also an indicator of whether students understand the probabilistic structure in the problem.

This finding is in line with research conducted by Nisa (2021), which shows that in the early stages of high-level thinking, students need to understand the basic structure of the problem, including identifying important components in the Opportunity material. The ability to identify sample points and sample spaces is the basis before students can perform more complex analysis, such as comparing odds values. In learning with the Realistic Mathematics Education (RME) approach, the introduction of key components through meaningful situations such as games, contributes positively to students' cognitive engagement and overall understanding of the concept of chance.

3. The Effect of Learning with Realistic Mathematics Education (RME) Approach Assisted by Traditional Game Congklak on Math Anxiety

The results showed that learning with the Realistic Mathematics Education (RME) approach assisted by the traditional game of congklak had a significant effect on reducing students' math anxiety. This is proven through the results of the Two Independent Sample t-Test statistical test, which produces a value of $t = -12.948$ with a p-value = 0.000 ($p < 0.05$). Thus, there is a significant difference between the level of math anxiety of students taught using the RME approach assisted by congklak and students taught with the scientific approach. Based on the results of data analysis, it was found that the traditional game of congklak plays a role in reducing students' math anxiety. This is shown by the decrease in the average score of math anxiety in each aspect after the treatment. In the affective aspect, students were happy and enthusiastic about learning because the learning atmosphere became more fun and less stressful. On the cognitive aspect, congklak helps students understand the concept of chance concretely and gradually. In the psychomotor aspect, students are directly involved in meaningful learning activities, so students' attention is more focused on the process. Thus, learning assisted by the traditional game of congklak is proven to contribute in reducing students' math anxiety.

Similar research conducted by Fitriyani et al (2018) showed that the RME approach can reduce math learning anxiety because students feel more comfortable with experience-oriented learning. In addition, Fadillah and Zulkardi (2020) in their research found that the traditional game of congklak can be used effectively in learning mathematics, because it provides a fun atmosphere and increases student activeness. The study showed that when students feel happy, safe, and motivated in the learning process, their anxiety about math decreases. Furthermore, traditional games such as congklak facilitate active learning through exploration, strategy and collaboration, all of which encourage students to focus on learning activities and not on math anxiety. This is based on Ashcraft's (2002) view that math anxiety can be reduced by creating positive and meaningful learning experiences, and keeping students away from abstract symbolic pressures.

Thus, the results of this study show that combining the RME approach with the traditional game of congklak not only supports the achievement of cognitive learning objectives, but also has a significant impact on students' affective aspects, especially in reducing math anxiety. This finding indicates that mathematics learning should not only focus on academic achievement, but also pay attention to the psychological aspects of students so that the learning process is optimal, comfortable and fun.

Conclusion

Based on the results of the research and discussion, it can be concluded that there is an effect of the application of learning using the Realistic Mathematics Education approach with the help of traditional games on students' higher order thinking skills and math anxiety. The results of data analysis show that there are differences in the average ability of higher order thinking and math anxiety of students in learning using the Realistic Mathematics Education approach assisted by traditional games of congklak and the Scientific approach after treatment. The results of data analysis showed that learning with

Realistic Mathematics Education approach assisted by traditional game of congklak is superior to the scientific approach based on the average increase in higher order thinking ability and based on the average decrease in math anxiety.

Suggestion

Based on the conclusions obtained, the advice that can be given is that increasing the ability to think at a high level and reducing students' math anxiety can be realized with realistic mathematics education approach assisted by traditional games of congklak , so that this approach can be one of the approaches that can be used by teachers in learning mathematics. In addition, for further researchers can develop this research by using realistic mathematics education approach assisted by traditional game of congklak on other materials.

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