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THE EFFECT OF REALISTIC MATHEMATICS EDUCATION LEARNING MODEL ON STUDENTS' SPATIAL ABILITY

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Abstract

This study aims to determine the effect of the Realistic Mathematics Education (RME) learning model on students' spatial ability and to describe the things that happen in learning with the RME model. The research method used is mixed methods with a concurrent embedded design where the quantitative approach uses a quasi-experimental design method with a pretest-posttest experimental control group design and a qualitative approach using descriptive methods. The population in this study were 11th-grade students of SMK Dharma Siswa. Researchers used simple random sampling where two samples were selected, namely 30 students of class XI Multimedia as the experimental class and 25 students of class XI Office Management Automation as the control class. The results of the analysis: (1) The average score of the experimental class was 84 while the control class was 75,9. (2) The average percentage of frequency of student activity in the experimental class is 84,07% of students who meet several activity criteria. (3) The interview sheet on the RME learning model showed that 94,17% of students responded positively. (4) the results of hypothesis testing using the Mann-Whitney Test with a value (sig.) of 0.001 < 0.05 which shows H_0 is rejected so that H_1 is accepted. From the results of the data analysis, it can be concluded that the RME learning model has an influence on students' spatial abilities, and learning mathematics with the RME model in the experimental class is said to be successful.

Keywords: Realistic Mathematics Education, Spatial Ability

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran *Realistic Mathematics Education* (RME) terhadap kemampuan spasial siswa dan untuk mendeskripsikan hal-hal yang terjadi dalam pembelajaran dengan model RME. Metode penelitian yang digunakan adalah *mixed methods* dengan desain *concurrent embedded* dimana pendekatan kuantitatif menggunakan metode *quasi experimental design* dengan rancangan *pretest-posttest experimental control group design* dan pendekatan kualitatif menggunakan metode deskriptif. Populasi dalam penelitian ini adalah siswa kelas XI SMK Dharma Siswa. Peneliti menggunakan *simple random sampling* dimana dua sampel terpilih yaitu 30 siswa kelas XI Multimedia sebagai kelas eksperimen dan 25 siswa kelas XI Otomatisasi Tata Kelola Perkantoran sebagai kelas kontrol. Hasil analisis: (1) Nilai rata – rata kelas eksperimen sebesar 84 sedangkan kelas kontrol sebesar 75.9. (2) Rata-rata persentase frekuensi aktivitas siswa kelas eksperimen yaitu 84,07% siswa memenuhi beberapa kriteria aktivitas. (3) Lembar wawancara terhadap model pembelajaran RME menunjukkan bahwa respons siswa 94,17% merespons positif. (4) hasil uji hipotesis dengan menggunakan Uji *Mann Whitney* dengan nilai (*sig.*) sebesar 0,001 < 0,05 yang menunjukkan H_0 ditolak sehingga H_1 diterima. Dari hasil analisis data tersebut, dapat disimpulkan bahwa model pembelajaran RME memiliki pengaruh terhadap kemampuan spasial siswa dan pembelajaran matematika dengan model RME pada kelas eksperimen dikatakan berhasil.

Kata kunci: Realistic Mathematics Education, Kemampuan Spasial

INTRODUCTION

Mathematics is a structured science that is patterned and systematic (Mubarok, 2022). In the development of science and technology, (Ndahawali et al., 2019) explains that mathematics plays an important role because in learning mathematics it is required to think creatively, critically, and thoroughly to solve a problem so that it is useful in everyday life.

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Interesting mathematics learning can make students accept that mathematics is fun. Based on the achievements of learning mathematics subjects (Kemendikbudristek, 2022) that learning material in mathematics at every level of education is accumulated through several fields of study namely Numbers, Algebra, Measurement, Geometry, Data and Opportunity Analysis, and Calculus. Geometry is key to understanding the various forms that exist in the world. The standard content for learning geometry according to the National Council Of Teacher Of Mathematics (NCTM, 2000) (Anggo et al., 2022) stated that learning geometry includes material including: (1) analyzing the properties of two-dimensional and three-dimensional shapes, (2) draw coordinates, (3) use transformation and symmetry to analyze mathematical problems, and (4) use a geometric approach to problem-solving.

Based on the results of interviews during the initial observation at SMK Dharma Siswa, information was obtained from the mathematics teacher who explained that students' understanding of mathematics, especially geometry material, still did not meet the minimum completeness criteria, there were only a few students whose grades met the completeness criteria. These unsatisfactory results indicate that most students do not like mathematics and the difficulty of geometry material. Students are required to be able to imagine an object in their minds in solving geometric problems. The ability of students to solve geometric problems is supported by a cognitive ability that is closely related to space. This ability is known as spatial ability.

Spatial ability is the ability to represent and manipulate spatial objects, the relationships between their elements, and the transformation of their forms (Fatmawati & Hasanah, 2018). Spatial ability can also be defined as a mental ability concerned with understanding, manipulating, rotating, and interpreting visual relationships (Soraya et al., 2021). Meanwhile (Rostina et al., 2021) explains that spatial ability is the ability to remember, create, perceive, change, store, and communicate spatial shapes. This explanation leads that spatial ability is very important in learning geometry. Based on the opinions of the experts above, it can be concluded that spatial ability is the ability to represent, visualize, determine and understand the relationship between objects and space.

To know the students' spatial ability, an indicator is needed. According to Azustiani (2017) in (Ismi et al., 2021) spatial ability is divided into three indicators as follows: (1) Spatial Visualization, namely students determine the composition of objects that have been manipulated both in position and shape, (2) Spatial Orientation, in which students determine the display of objects from different directions, and (3) Spatial Relations, namely students determine the relationship of several objects.

In solving geometry problems, especially in the three-dimensional sub-matter, students must have spatial abilities. This is in line with research (Fitriana & Lestari, 2022) which states that spatial abilities need to be possessed to learn geometry so the importance of this spatial ability must exist in every student, so teachers need to be required to pay attention to this ability in classroom learning. However, the importance of this spatial ability is not by the facts in SMK Dharma Siswa. Based on the observation test 30 class XI students with the instruments given were: "Pay attention to the picture of the tube! The tubes are arranged in an upright position and consist of 6 color choices starting from salmon, purple, turkish, green, sky blue, and red. (a) Draw the shape of the tube seen from the top side, (b) if you stand from behind the tube, state the color order, (c) draw the tube rotated 90°, and (d) draw the tube in a lying position, is the picture the same as the picture in an upright position? Explain!"

Here is an illustration of the tube:

Figure 1. Tube Illustration Example

The results show that the students' mathematical spatial ability on the observation test given is included in the low category. Here is the answer from one of the students.

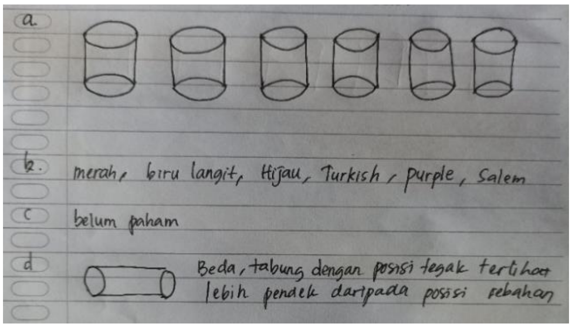

Figure 2. One of Class XI Student's Answers

Based on Figure 2, it can be seen that the student's answers only provide makeshift explanations which indicate that students do not understand spatial problems. It is suspected that the factors causing low spatial ability are students who only tend to memorize formulas and do not understand the concept of geometric shapes correctly. Another factor is the teacher's inaccuracy in applying the learning model so that it does not attract students' attention and interest which results in low student mathematics learning outcomes.

Learning models that construct students' abilities such as Realistic Mathematics Education can solve this problem so that students can visualize and determine the most appropriate model to solve the problems given and are expected to improve students' spatial abilities. The RME learning model is a learning process that is by the characteristics and principles of real learning (Panggabean, 2021). The RME learning model (Sumaka, 2022) is a mathematics learning model that emphasizes students' activeness in seeking and developing their knowledge by exploring various real-world problems. Meanwhile (Nuryami et al., 2022) explains that the RME learning model is a learning model based on real life with an emphasis on mathematics that is considered abstract to become real. Based on some of the opinions above, it can be concluded that the Realistic Mathematics Education (RME) learning model is a real-life based mathematics learning model that emphasizes student activity in solving problems.

The RME learning model has its steps in its implementation. Ningsih (2014) states that there are four main steps in the learning process using the RME learning model, namely: (1) Understanding contextual problems, the teacher gives contextual problems and asks students to understand these problems, (2) Solving contextual problems, the teacher asks students to solve contextual problems in their way, (3) Comparing and discussing answers, the teacher asks students to compare and discuss their answers in small groups, (4) Concluding, the teacher guides students to conclude (Sudi et al., 2022).

However, the importance of the RME model in learning does not match the facts at SMK Dharma Siswa. Based on the results of observations made by researchers, it was found that the lesson plan used by the mathematics teacher there did not include a model and did not explain the learning design used. The teacher only applies ordinary mathematics learning because it is very difficult to apply other models to lesson plans. Learning ordinary mathematics makes students tend to be passive so the interaction between teachers and students is very low.

Seeing the existing problems, we need a learning model that is expected to be able to improve students' spatial abilities and students can enjoy the learning process such as Realistic Mathematics Education. This is in line with research (Fatmawati & Hasanah, 2018) which shows that there is an effect of a realistic mathematics education approach on spatial reasoning abilities on volume and surface area material. Research (Puspaningrum et al., 2021) also has similar results that there is an increase in mathematical spatial abilities with interactive digital book learning media based on a realistic mathematics approach. Research (Fadriyah & Hendriana, 2021) reinforces previous research which states that a realistic mathematics approach can improve students' spatial abilities. It can also be seen that students enjoy the learning process when using a realistic mathematics approach.

Based on the description above, the problem to be examined is, "Is there an influence of the RME learning model on students' spatial abilities, and how is the learning process with the RME model?" This study aims to determine the effect of the RME learning model on students' spatial abilities and to describe things that happen in learning with the RME model. Therefore the researcher wants to use the RME learning model because this learning model is based on real things for students, so it allows students to implement this learning in everyday life and the objectives of this research can be achieved.

METHODS

The research method used is mixed methods with a concurrent embedded design where the quantitative approach uses a quasi-experimental design method with a pretest-posttest experimental control group design and the qualitative approach uses a descriptive method. The place and time of research were carried out at Dharma Siswa Vocational School on 24 February 2023 – 10 April 2023. The population in this study was class XI students at SMK Dharma Siswa. The researcher used simple random sampling where two samples were selected, namely class XI MM as an experimental class of 30 students and XI OTKP as a control class of 25 students. Data collection techniques were carried out using test instruments, observation sheets to observe activities, documentation, and student interview sheets to determine student responses.

The grid of students' spatial ability test questions is shown in Table 1 below.

Table 1. Student Spatial Ability Test Grid

Variable	Basic Competencies	Instrument Indicator	Question Type	Item Number
Student's Spatial Ability	Analyze points, lines, and planes in three-dimensional geometry	Spatial orientation	Essay	1,2,3,4,5
		Spatial visualization		
		Spatial relation		

Data analysis techniques in this study used descriptive analysis and inferential analysis. Descriptive analysis is used to calculate the average score of observations of the implementation of learning, the percentage of student activity during learning, determine the average student response score and analyze data on students' spatial abilities.

Meanwhile, inferential analysis is used to find out the difference in the average scores of students' spatial abilities between the RME learning model and ordinary mathematics learning. In testing the hypothesis, for normally distributed data a parametric test will be used, namely the independent sample t-test, if the data is not normally distributed then a non-parametric test is used, namely the Mann-Whitney which in its calculations utilizes the SPSS for Windows program.

RESULTS AND DISCUSSION

In this study, what was produced was the effect of the RME learning model on students' spatial abilities and described things that happened in learning with the RME model. Data analysis of students' spatial abilities before being given different treatments in the experimental class and the control class, both classes were given a pretest to determine students' initial abilities. The average value for the experimental class is 47.3 and for the control class is 46.7. After being given treatment, at the end of the meeting after the material has been taught, students are given a posttest to determine students spatial abilities as seen from the average posttest. The experimental class (XI MM) using the RME learning model obtained an average posttest of 84 while the control class (XI OTKP) using ordinary mathematics learning obtained an average posttest of 75.9. Based on the average post-test results, learning using the RME learning model has better spatial abilities.

The aspects observed in the implementation of learning mathematics by applying the Student RME learning model include several aspects. These aspects were observed directly by the observer during the learning process which was observed from meetings I, II, and III.

The data obtained from the instrument are summarized at the end of each meeting. The summary results of each observation are presented in Table 2 below.

Table 2. Summary of Results of Observation Analysis of Learning Implementation

	Learning 1	Learning 2	Learning 3
Sum	62	64	65
Mean	3,64	3,76	3,82
Overall Mean		3,74	

Based on Table 2. the results of the analysis of observational data in the experimental class on the implementation of learning by learning mathematics through the RME learning model for 3 meetings show that the level of the teacher's ability to manage learning achieves an average score of 3.74 (in the very good category). Thus the teacher's performance at the next meeting can be improved by paying attention to aspects that were rated low at the previous meeting.

Furthermore, descriptions of student activities with observation sheets to obtain one type of data supporting the criteria for learning effectiveness. This instrument contains instructions and 7 indicators of observed student activity. Observations were carried out using observers observing student activities carried out during three meetings. The data obtained from the instrument are summarized at the end of each meeting. The summary results of each observation are presented in Table 3 below.

Table 3. Summary of Student Activity Analysis Results

Learning	Percentage of Student Activity per Observation Aspect (%)						
	Positive Activity						Negative Activity
	1	2	3	4	5	6	7
I	83,33	100	83,33	86,67	73,33	100	16,67
II	73,33	86,67	80	76,67	73,33	86,67	13,33
III	80	93,33	86,67	83,33	73,33	93,33	13,33
Mean	78,89	93,33	83,33	82,22	73,33	93,33	14,44
Overall Mean	84,07						14,44

Based on Table 3, the results of observations of student activity in the experimental class while participating in mathematics learning by applying the RME learning model to Class XI Multimedia SMK Dharma Siswa students show that students are active in learning and have met the active criteria because according to student activity indicators that student activity is said to be successful /effective if at least 75% of students are actively involved in the learning process (Prayogo, 2022). While the results of the analysis of student activity observation data show an average percentage of positive activity of students with the RME learning model, namely 84.07%. It can be concluded that students have actively participated in the mathematics learning process through the RME learning model.

After participating in mathematics learning that applied the RME learning model, there were results of analysis of student response data with interview sheets filled out by 30 students briefly. The results of the analysis of student response data to learning mathematics by applying the RME learning model are in Table 4 below.

Table 4. Summary of Student Response Analysis Results

Respondent	Percentage of Student Response Frequency	
	Positive	Negative
Student	94,17	5,83

From the results of the analysis of the interview sheets regarding student responses in the experimental class, it was found that 94.17% of students gave a positive response to the implementation of learning mathematics through the RME learning model. This is in line with the opinion of (Nuralan, 2022) which explains that response is an attitude that indicates active participation in engaging in a lesson. In other words, a good and effective learning model makes students respond positively after they participate in mathematics learning activities.

Before knowing whether there is a difference in the average score of students' spatial abilities between the RME learning model and ordinary mathematics learning, it is necessary to carry out a data normality test. The following are the results of the pretest and posttest data normality tests.

Table 5. Summary of Normality Test Results

Data	Class	N	Sig.	Pronouncement
Pretest	Experiment	30	0,002	Not Normal Distribution
	Control	25	0,003	Not Normal Distribution
Posttest	Experiment	30	0,078	Normal Distribution
	Control	25	0,002	Not Normal Distribution

Based on the results of the normality test in Table 5. the data is not normally distributed, so test the hypothesis using a non-parametric test, namely the Mann-Whitney test. Testing this hypothesis using the help of the SPSS 25 for Windows program, the results of which can be seen in Table 6 below.

Table 6. Summary of Mann-Whitney Test Results

Data	Mann-Whitney	Asymp. Sig. (2-tailed)	Pronouncement
Posttest	183,000	0,001	H_0 rejected

Based on Table 6 above, the results of the Mann-Whitney test on the posttest, show a probability value (sig.) < 0.05 (0.001 < 0.05) which indicates H_0 is rejected so H_1 is accepted meaning that in general there is a difference in the average score the students' spatial ability is significant between the RME learning model and ordinary mathematics learning.

From the results of the descriptive and inferential analysis obtained, it turns out to be quite supportive of answering the existing problems. This is reinforced by the results of research (Fadriyah & Hendriana, 2021) which states that a realistic mathematics approach can improve students' spatial abilities. It can also be seen that students enjoy the learning process when using a realistic mathematics approach.

Thus it can be concluded that the RME learning model significantly influences students' spatial abilities and learning mathematics with the RME model in the experimental class is said to be successful.

CONCLUSION

Based on the results of the discussion above, it can be interpreted that in general, the RME learning model has a significant influence on students' spatial abilities. This can be seen from the difference in the average score of spatial ability between the RME learning model and ordinary mathematics learning. Based on the results of observations it can also be seen that students enjoy the learning process. This can be seen in the score of the observation sheet analysis results and student responses which are in the good category so that learning mathematics with the RME model in the experimental class is said to be successful. The RME learning model is very suitable to be applied in the learning process in elementary to high schools. Through this RME model, students can improve their spatial abilities where this ability is useful in solving geometric problems that students will encounter both in the context of learning and everyday life so that the optimization of mathematical linkages to students becomes wider.

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