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Analysis of Metacognitive Approach to The Mathematics Reasoning Ability of Students of State Elementary School of Pamulang 01

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Abstract

This research was motivated by students' low mathematical reasoning ability in elementary schools and the demands of numeracy literacy through the minimum competency assessment (AKM) program launched by the government, requiring students to improve their reasoning abilities by applying a metacognitive approach. This study aimed to determine the effectiveness of the metacognitive approach in improving students' mathematical reasoning abilities on the material of the spatial structure. The method used in this study was an experimental research method with a quasi-experimental approach, with a sample size of 59 students (31 students in the control class and 28 students in the experimental class), with a pretest-posttest-only control group design. The results obtained from the calculation of the independent sample t-test revealed a t-count of 0.356, less than a t-table of 2.002. It indicates no difference in students' mathematical reasoning ability between the experimental and control classes. Thus, the metacognitive learning approach did not significantly affect the mathematical reasoning ability of students in sixth grade of State Elementary School of Pamulang 01. In other words, it can be said that the metacognitive learning approach for students at State Elementary School of Pamulang 01 was not appropriate for learning mathematics. The results of this study are expected to be useful to related parties who can use it, such as school principals, teachers, parents, students, and further researchers.

Keywords: Metacognitive Approach, Mathematical Reasoning Ability, Spatial Structure

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Abstrak

Penelitian ini dilatarbelakangi oleh rendahnya kemampuan penalaran matematis siswa di sekolah dasar dan tuntutan literasi berhitung melalui program assesmen kompetensi minimum (AKM) yang dicanangkan pemerintah, mengharuskan siswa untuk meningkatkan kemampuan penalarannya dengan menerapkan pendekatan metakognitif. Penelitian ini bertujuan untuk mengetahui efektivitas pendekatan metakognitif dalam meningkatkan kemampuan penalaran matematis siswa pada materi struktur ruang. Metode yang digunakan dalam penelitian ini adalah metode penelitian eksperimen dengan pendekatan quasi eksperimen, dengan jumlah sampel 59 siswa (31 siswa kelas kontrol dan 28 siswa kelas eksperimen), dengan desain pretest-posttest control group. Hasil yang diperoleh dari perhitungan independent sample t-test menunjukkan t-hitung sebesar 0,356, lebih kecil dari t-tabel sebesar 2,002. Hal ini menunjukkan tidak ada perbedaan kemampuan penalaran matematis siswa antara kelas eksperimen dan kelas kontrol. Dengan demikian, pendekatan pembelajaran metakognitif tidak berpengaruh secara signifikan terhadap kemampuan penalaran matematis siswa kelas VI SDN Pamulang 01. Dengan kata lain, dapat dikatakan bahwa pendekatan pembelajaran metakognitif pada siswa SDN Pamulang 01 adalah tidak cocok untuk pembelajaran matematika. Hasil penelitian ini diharapkan dapat bermanfaat bagi pihak-pihak terkait yang dapat memanfaatkannya, seperti kepala sekolah, guru, orang tua, siswa, dan peneliti selanjutnya.

Kata Kunci: Pendekatan Metakognitif, Kemampuan Penalaran Matematika, Struktur Spasial

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INTRODUCTION

Reasoning ability is a necessity that every student must possess to solve their life problems, especially amid the demands of 21st-century learning, which requires students to have critical and creative thinking competencies and high-order thinking skills (HOT). In addition, critical thinking skills and reasoning are the foundation for solving problems, finding new solutions, and generating new, varied, and unique ideas (Leen et al., 2014; Redhana, 2019).

In this case, mathematical reasoning is the most important part of thinking, which involves forming generalizations and drawing valid conclusions about ideas and how they relate to them (Yusdiana & Hidayat, 2018). As one of the disciplines taught at every level of education, mathematics certainly has an important role in achieving educational goals. Through the objectives of learning mathematics, the educational objectives should be achieved properly so that with the established mathematics learning objectives, teachers should be able to maximize their potential to print students according to what is expected. As determined by NCTM (2000), five competencies in learning mathematics include mathematical problem solving, mathematical communication, mathematical reasoning, mathematical connections, and mathematical representation (Maulyda in Rosyidah et al., 2021).

To solve problems related to mathematics, of course, students must have good reasoning abilities. Mathematical reasoning ability is needed in constructing the mathematical knowledge possessed by students so that students can find a way out of the mathematical problems they face. Mathematical reasoning ability is to connect problems into an idea so that it can solve mathematical problems (Salmina & Nisa, 2018; Ramdan & Roesdiana, 2022).

In the data on the results of Indonesian students' achievements in the 2015 TIMSS implementation report in the field of Mathematics, Indonesia was below the international average score, which was only 397 out of a mean of 500 points and was ranked 44th out of 49, down from 38th out of 38 countries, with a score of 386 points in 2011 (Nizam in Runisah et al., 2021; Hadi & Novaliyosi, 2019). Besides, students' mathematical reasoning abilities score level was very low. Therefore, an effective and practical learning approach is needed to encourage students' reasoning abilities in learning mathematics in elementary school.

On the other hand, the metacognitive ability is awareness of one's cognition, how cognition works, and how to manage it (Erlin et al., 2021). With good metacognitive awareness, students have a better foundation for thinking about what is being done and knowing its reasons (Jankowski & Holas, 2014; Nurwidodo et al., 2021). Metacognitive skills are related to abilities obtained from monitoring, guiding, and controlling one's learning process and behavior in solving problems (Zohar, 2012; Sembiring et al., 2021).

Metacognitive strategies are defined as learning strategies involving thinking or knowledge about the learning process, planning for learning, monitoring learning during progress, and assessing learning after completing tasks (Nuryani et al., 2014).

Moreover, a metacognitive strategy is a strategy in the process of determining the planning and monitoring of cognitive activities and evaluating the results of cognitive activities in facilitating the organization and understanding of the subject matter (Zulfikar, 2019).

In the learning process, students are given the opportunity to plan, monitor, and reflect (evaluate) the process of cognitive activity that has been carried out during the learning process. In this regard, the teacher invites students to reflect on what they have made or learned to know the mistakes and difficulties in understanding a certain concept. It allows the occurrence of metacognitive activities in students. Thus, with control and reflection on all cognitive activities, it can raise awareness in students about the thought processes that have been carried out in learning.

Some of the research data that have been described previously uncovered that students' mathematical reasoning abilities were still very low. It can be seen from the facts in the field that came from teachers' assumptions at State Elementary School of Pamulang 01, providing statements about students' weaknesses in using mathematical reasoning abilities in working on mathematical problems given by the teachers. Therefore, the researchers decided to make the State Elementary School of Pamulang 01 the research location.

METHODS

The research method used by the researcher was an experimental research method with a quasi-experimental approach, namely research carried out without forming a new class through randomization but by accepting the existing class and determined by the school. This study consisted of two classes: the experimental and the control classes. The metacognitive learning approach was a treatment for the experimental class, while the control class used conventional learning. The number of samples used was 59 people, with 31 people in the experimental class and 28 people in the control class. The form of the experimental design chosen was a pretest-posttest control group design, as shown in the following.

Table 1. Pretest-Posttest Control Group Research Design

Experimental Group	**O_1**	**X**	**O_2**
Control Group	O_3		O_4

Description:
X : Treatment using metacognitive approach
O_1 : Experimental pre-test
O_2 : Experiment post-test
O_3 : Pre-test control
O_4 : Post-test control

The research instrument in the form of essay questions consisted of ten items and had gone through testing the validity, reliability, and level of item difficulty with an expert validation approach (Azwar in Setiawan, 2017). The data analysis technique used was the comparison test of the mean of the two groups and statistically using the independent sample t-test with a 95% confidence level. The formula used is:

$$\boxed{t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2 + s_2^2}{n_1 + n_2}}}}$$

Figure 1. T-test Formula

The data processing technique used Ms. Excel 2019 in the form of data analysts as software to test data and determine descriptive statistics of the data.

RESULTS AND DISCUSSION

Description of Research Results

The description of the data presented in this section included data on the experimental class (treatment variable) and the control class, each of which was 28 people. The description of each class is as follows:

Experimental Class Mathematical Reasoning Ability

The score of mathematical reasoning ability in the experimental class was obtained based on the measurement results using the description of the questions given before and after the metacognitive approach was given. Based on the data analysis results of the pre-test, the experimental class obtained a maximum score of 97.5; a minimum value of 20; a range of 77.5; a mean of 49.55; a standard deviation of 18.61; a variance of 346.32; respondents of 28. Meanwhile, at the post-test, the experimental class obtained a maximum score of 100; a minimum value of 40; a range of 60; a mean of 77.14; a standard deviation of 15.44; a variance of 238.29; respondents of 28. The results of these calculations can be seen in Table 4.1 below:

Table 2. Description of Mathematical Reasoning Ability Data in Experimental Class

Measurement	***Pre-test***	***Post-test***
Mean	49.55	77.142
Standard Deviation	18.60	15.43
Sample Variance	346.3	238.29
Range	77.5	60
Minimum	20	40
Maximum	97.5	100
Respondent	28	28

Based on the pre-test results in Table 4.2, it can be concluded that before being given treatment, the category of students' mathematical reasoning ability scores in the experimental class revealed that two students got very high scores, four students got high scores, five students got moderate scores, nine students scored low, and eight people scored very low. Meanwhile, the post-test results in the category table can be concluded that after being given treatment in the form of a metacognitive approach, the category of students' mathematical reasoning ability scores in the experimental class uncovered 12 students got very high scores, ten students got high scores, two students got moderate scores, four students got a low score, and no student got a very low score.

The frequency distribution of the experimental class's mathematical reasoning ability scores can be seen in the bar chart below:

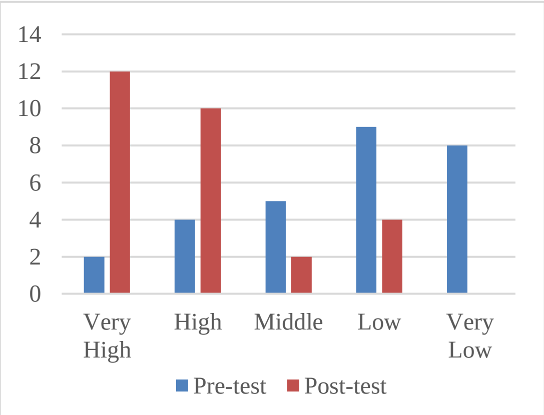

Figure 2. Frequency Distribution of Mathematical Reasoning Ability Scores in The Experimental Class

As for the mathematical reasoning ability of students from the experimental class, the indicators are presented in the following Figure 3. With indicators of inductive reasoning ability, it is transductive, i.e., drawing conclusions from one particular case or trait applied to other special cases, and in indicators of deductive reasoning ability, calculations based on certain rules or formulas were carried out.

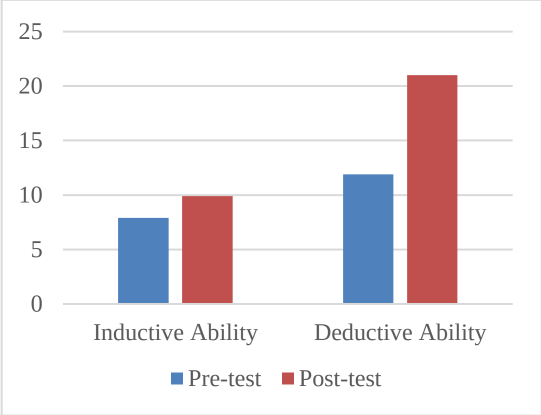

Figure 3. Mathematical Reasoning Ability of Experimental Class on Every Indicator

Based on the chart in Figure 3, it can be seen that the experimental class obtained a mean score on the inductive indicator when the pre-test was 7.89, and the post-test was 9.89 (with the ideal score on the inductive reasoning ability indicator being 16). As for the deductive indicators, the mean score for the pre-test was 11.9, and the post-test was 21 (with the ideal score on the deductive reasoning ability indicator being 24). Based on these data, it can be concluded that students' mathematical reasoning abilities on each indicator increased after learning by being given a metacognitive approach.

Control Class Mathematical Reasoning Ability

The score of mathematical reasoning ability in the control class was obtained based on the measurement results using the description of the questions given before and after the learning process was carried out. Based on the data analysis results of the pre-test, the control class obtained a maximum score of 77.5; a minimum value of 7.5; a range of 70; a mean of 38.55; a standard deviation of 19.341; a variance of 374.072; respondents of 31. Meanwhile, at the post-test, the control class obtained a maximum score of 100; a minimum value of 27.5; a range of 72.5; a mean of 70,403; a standard deviation of 20.957; a variance of 439,207; respondents of 31. The results of these calculations can be seen in Table 3 below:

Table 3. Description of Mathematical Reasoning Ability Data in Control Class

Measurement	***Pre-test***	***Post-test***
Mean	38.548	70.40
Standard Deviation	19.340	20.95
Sample Variance	374.07	439.20
Range	70	72.5
Minimum	7.5	27.5
Maximum	77.5	100
Respondent	31	31

Based on the pre-test results in the category group, it can be concluded that before the learning process was carried out, the category of students' mathematical reasoning ability scores in the control class uncovered that no student got very high scores, five students got high scores, three students got moderate scores, five students scored low, and 18 students scored very low. Meanwhile, based on the post-test results in the category group, it can be concluded that after the learning process was carried out, the category of students' mathematical reasoning ability scores in the control class disclosed that 11 students scored very high, ten students scored high, four students received moderate scores, two students got a low score, and four students got a very low score. The frequency distribution of the value of the control class's mathematical reasoning ability can be seen in Figure 4.

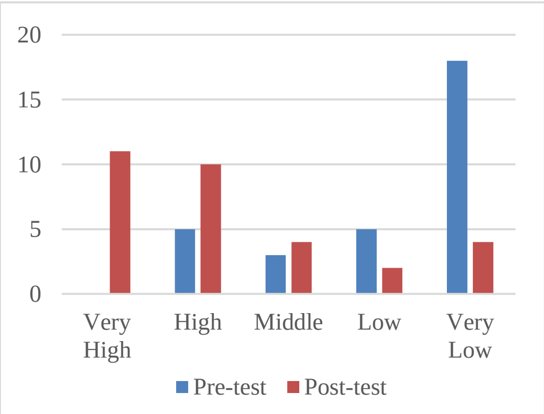

Figure 4. Frequency Distribution of Mathematical Reasoning Ability Scores in The Control Class

As for the mathematical reasoning ability of students from the control class, the indicators are presented in Figure 5 below. With indicators of inductive reasoning ability, transductive is drawing conclusions from one particular case or trait applied to other special cases, and indicators of deductive reasoning ability, calculations based on certain rules or formulas were carried out.

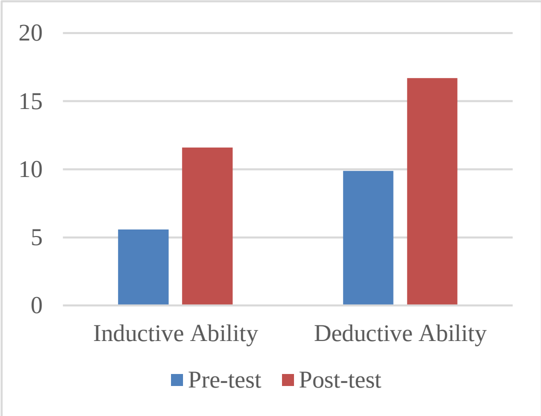

Figure 5. Mathematical Reasoning Ability of Control Class on Every Indicator

Based on the chart above, it can be seen that the control class obtained a mean score on the inductive indicator when the pre-test was 5.58 and the post-test was 11.6 (with the ideal score on the inductive reasoning ability indicator being 16). As for the deductive indicators, the mean score for the pre-test was 9.87, and the post-test was 16.7 (with the ideal score on the deductive reasoning ability indicator being 24). Based on these data, it can be concluded that the students' mathematical reasoning ability on each indicator increased after learning.

Comparison of Mathematical Reasoning Ability between Experimental and Control Group

Based on this description, the researchers concluded that the overall description of the data both in the experimental class and the control class could be seen in Table 4 below.

Table 4. Mathematical Reasoning Ability Data of Experimental and Control Class

Measurement	Class			
	Experiment		**Control**	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Mean	49.55	77.14	38.54	70.40
Standard Deviation	18.60	15.43	19.34	20.95
Sample Variance	346.3	238.29	374.07	439.2
Range	77.5	60	70	72.5
Minimum	20	40	7.5	27.5
Maximum	97.5	100	77.5	100
Respondent	28	28	31	31

The difference in the mean value of students' mathematical reasoning abilities (overall) both in the experimental class and the control class can be seen in the chart below:

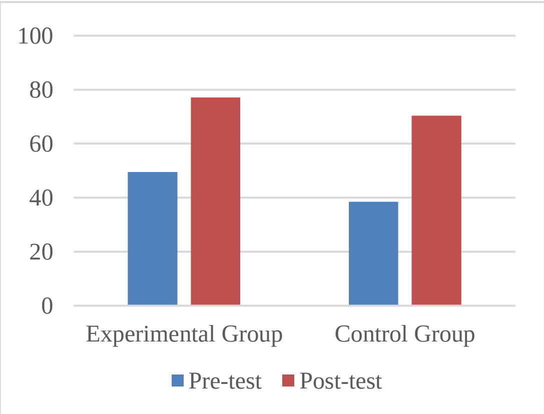

Figure 6. Experimental and Control Class Mean

Based on the chart in Figure 6, it can be seen that the mean score for the experimental class was 49.55 at the pre-test and 77.14 at the post-test. Meanwhile, the mean score for the control class was 38.54 on the pre-test and 70.403 on the post-test. In this case, the experimental class received treatment using a metacognitive approach, and the control class used ordinary learning. From the comparison of the mean scores both before and after receiving treatment, it can be seen that the experimental class had a higher score than the control class.

Based on the data obtained and described previously, to test the research hypotheses, the researchers used an independent t-test (polled variance) and a paired t-test (related sample) with the help of the Ms. Excel 2010 program and a significance level of 0.05. Based on the t-test results using the t-independent test (polled variance), the t-value was 0.35, and the t-table was 2.002. Thus, based on the test criteria of t-count < t-table (0.35 < 2.002), it can be concluded that there was no positive difference between students whose learning used a metacognitive approach and students whose learning used ordinary learning. It means that this metacognitive approach to learning did not affect the mathematical reasoning abilities of sixth-grade students at State Elementary School of Pamulang 01.

As for the sample t-related test, the output results were obtained as shown in the table below.

Table 5. T-test Values

	t_{count}	t_{table}
Experimental Group	9.19	1.70
Control Group	9.36	1.69

Based on the table, the data obtained by the t-count was greater than the t-table in the experimental and control classes. Thus, based on the decision-making criteria, it can be concluded that t-count > t-table (9.19 > 1.70) and (9.36 > 1.69). It indicates that there was a positive and significant difference between the ability of mathematical reasoning before and after learning in both the experimental and control classes. In this case, the experimental class received treatment in a metacognitive approach, and the control class did not receive any treatment (ordinary learning).

Furthermore, the researchers used the normalized gain formula to measure the difference in students' mathematical reasoning abilities between the class treated in the form of a metacognitive approach and the class not treated. Based on the calculation results, it was found that after being given treatment in the form of a metacognitive approach, the mathematical reasoning ability of the experimental class increased by 0.564. Meanwhile, for the control class not given a metacognitive approach, the students' mathematical reasoning ability increased by 0.538.

Based on the results of the data calculation, it can be concluded that the difference in the mathematical reasoning ability of students given treatment in the form of a metacognitive approach (experimental) with the reasoning ability of students not given a metacognitive approach (control) was only 0.026. Based on this, the researchers could conclude that there was no positive and significant difference in the mathematical reasoning abilities of students whose learning used a metacognitive approach (experimental) with the reasoning abilities of students whose learning did not use a metacognitive approach (control).

Discussion

Moreover, the metacognitive approach is a teacher's point of view in understanding the meaning of learning, which emphasizes students' self-awareness about how, why, and what they are actually learning. Thus, in this metacognitive approach, the teacher will also assist students in increasing their self-awareness when participating in the learning process so that students will always accept the learning provided by the teacher. Awareness in learning mathematics is needed because the metacognitive approach itself is a learning approach that emphasizes students' self-awareness in monitoring themselves when learning. It is in line with the opinion of Jankowski and Holas (2014) that good metacognitive students have more foundation in thinking about what is being done and know the reasons for doing it (Nurwidodo et al., 2021)

Furthermore, students at the age of sixth grade of elementary school had not been able to learn independently to solve the problems presented in a question (Setiadi et al in Munaji & Setiawahyu, 2020). Because this metacognitive approach is closely related to independent learning and problem-solving, it aligns with the opinion of Ferrari and Sternberg (Santrock in Nurfaizah et al., 2015), who argued that metacognitive knowledge involves monitoring and reflecting one's thoughts. It includes factual knowledge, such as knowledge of a task, goal, or self and knowledge of how and when to use specific procedures to solve a problem.

Based on the description stated previously, this metacognitive approach had not been able to raise students' self-awareness when carrying out learning. It could occur due to a lack of student motivation in carrying out the learning process. Regarding motivation, there are two types of motivation in learning, namely internal and external. In this study, the researchers assumed that students given this metacognitive approach did not provide enough motivation when studying so that their mathematical reasoning abilities did not increase. It is consistent with Jufri et al. in Masrura (2013), stating that "achievement motivation has an important role in learning because, in this motivation, it can direct and encourage one's learning activities so that he can achieve high learning outcomes."

Every individual who carries out the learning process should get motivation for himself, both from the individual (internal) and outside the individual (external). However, elementary school-aged students generally still need outside help or encouragement to do everything. One of the encouragements or motivations from the outside can be given by the teacher. Thus, in this case, the teacher plays a major role as a class manager, including providing full motivation to students, especially elementary school-age students. It is in agreement with what was expressed by Uno in *Orientasi Baru dalam Psikologi Pendidikan [New Orientations in Educational Psychology]* that teachers should be able to create an environment to carry out appropriate and good activities and be directed at the goals to be achieved by creating an atmosphere of security, opposing and stimulating students to learn, and providing satisfaction in achieving the specified goals.

Based on the description put forward, it can be concluded that based on the data results analysis, it was found no significant difference between the mathematical reasoning abilities of students whose learning used a metacognitive approach (experimental) and the reasoning abilities of students whose learning used ordinary learning (control). Thus, it can be concluded that the metacognitive approach taken by the teacher in learning did not affect the mathematical reasoning ability of sixth grade students at State Elementary School of Pamulang 01.

CONCLUSION

Based on the research results and discussion carried out and described above, it can be concluded several things.

There was no significant difference in the mathematical reasoning ability of students given a metacognitive approach (experimental) with the mathematical reasoning ability of students not given a metacognitive approach (control). The conclusion was obtained based on the calculation results of the hypothesis test using the independent t-test obtained a t-count of 0.356 and a t-table of 2.002 so that the t-count<t-table (0.356 < 2.002). It means that the metacognitive approach did not affect the mathematical reasoning abilities of sixth-graders at State Elementary School of Pamulang 01.

Based on data processing and discussion analysis, the following research results were obtained. In sixth grade class A, given the metacognitive approach (experimental class), the mean pre-test score was 49.55, and the mean post-test was 77.14, with a mean gain score of 0.564. Meanwhile, for sixth grade class C, not given a metacognitive approach (control class), the mean pre-test score was 38.54, and the mean post-test was 70.40, with a mean gain score of 0.538. Thus, the difference in the gain of the two groups was 0.026. From these data, it can be concluded that the difference in mathematical reasoning ability in the experimental class with mathematical reasoning ability in the control class based on the gain score was only 0.026. It indicates a slight difference (the mathematical reasoning ability of students in the experimental class was better than in the control class) but not significant.

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