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The effectiveness of applying mathemagic as an alternative method of Joyful learning for junior high school students

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***Abstract*:**
This study aims to analyze the effectiveness of the mathemagic method as one of the alternatives to joyful learning methods for junior high school students. The objects of this study were students of State Junior High School 1 Situbondo, consisting of 30 students in the experimental class and 30 students in the control class. Data were collected through test instruments and questionnaires, then analyzed using descriptive and inferential statistics in the form of paired sample t-tests, and N-Gain tests. The results of the study showed that the application of the mathemagic method as an alternative joyful learning is effective in improving student learning outcomes on HOTS questions, with an average increase in scores from pre-test (68.80) to post-test (87.83) of 19.03 points in the experimental class compared to pre-test (63.23) to post-test (73.20) of 9.97 points in the control class, sig.t (p-value) 0.000 < 0.05. The N-Gain analysis was 61.71% (moderate category) in the experimental class, while the control class was 27.24% (low category). In addition, 85% of students gave a positive response to this method, especially in terms of motivation and interest in learning because it was considered interesting and enjoyable.

Keywords: Effectiveness, Mathemagic; HOTS; Joyful Learning Method.

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Introduction

Education has a fundamental role in shaping individuals who are able to think critically, creatively, and innovatively. According to Akiba et al. (2025) human development does not only depend on instinct, but requires education as a means of guidance in order to achieve optimal potential. Education not only contributes to individual well-being, but also plays an important role in the progress of society and civilization (As' ari et al., 2017). In line with this statement, Mukhlis and Tohir (2019) emphasized that in the era of the Industrial Revolution 4.0, education must be oriented towards the development of high-level thinking skills (*Higher Order Thinking Skills*), the use of technology, and improving communication and collaboration skills.

In the learning system, the methods applied must be able to develop HOTS, especially in subjects that require logical and analytical thinking skills such as mathematics. Effective learning does not only focus on passive information transfer, but must also encourage students to think critically, explore concepts, and apply knowledge in real contexts (Darmawan et al., 2024). Therefore, an innovative approach is needed in mathematics learning to improve HOTS optimally.

Mathematics is a discipline that plays a role in building logical, analytical, and systematic reasoning skills. According to Kristina Yatipai in (S. Sugiyono, 2017) it is emphasized that mathematics does not only function as a calculation tool, but also as a basis for the development of science and technology. This statement is in line with the view of Carl Friedrich Gauss who stated that "Mathematics is the Queen of Sciences" and Tohir et al. (2020) who emphasized that "Mathematics is the Bedrock of Any Contemporary Order of Science". However, in the field, many students have difficulty understanding mathematical concepts due to learning methods that tend to focus on memorizing formulas without in-depth understanding (Maswar, 2019). As a result, students' interest in learning mathematics is low, and they have difficulty applying concepts to solve complex problems. Researchers will categorize HOTS levels of students' test results into three groups, namely (C4) analyzing, (C5) evaluating, and (C6) creating (Tohir et al., 2022). This classification is based on examining each content associated with the revised Bloom's taxonomy (Nurhasanah et al., 2023). Therefore, mathematics learning must be designed so that students do not only memorize formulas, but also understand concepts, analyze problems, and find creative and innovative solutions (Mukhlis et al., 2018). This concept is reinforced by Conklin (2012) who stated that high-level thinking skills (HOTS) include critical and creative thinking skills that have an important role in the learning process.

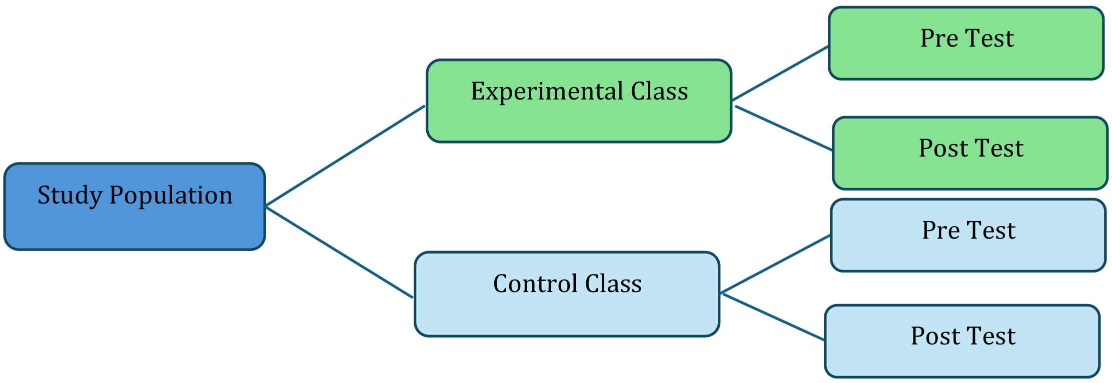
One method that can be used to improve students' HOTS in mathematics learning is the mathemagics method. This method is an innovative approach to understanding mathematical concepts through tricks, games, and entertainment elements that attract students' interest (Astindari et al., 2022). With this approach, students are not only directed to memorize formulas, but also understand concepts more creatively and exploratively (Astindari et al., 2023). In addition, this method also provides space for students to think critically and develop problem-solving skills, which are the main components of HOTS (G. D. P. A. Sari et al., 2022). Therefore, the use of the Mathemagics method is believed to have a positive impact on improving students' HOTS in mathematics learning. Previous studies have shown that the Mathemagics method is effective in improving student learning outcomes and motivation in mathematics learning (Astindari et al., 2022; A. Siregar et al., 2023). However, there are still several research gaps that need to be explored further. Most previous studies have focused on improving general learning outcomes without conducting an in-depth analysis of its impact on HOTS, especially in analysis skills (C4), evaluation (C5), and synthesis (C6) based on the revised Bloom's Taxonomy. In addition, the Mathemagics method is more widely applied to students with special needs (Jitendra et al., 2016; Ozkan & Umdu Topsakal, 2021), while studies on its effectiveness on regular students are still limited.

HOTS measurement instruments in previous studies generally only assess understanding of basic concepts without using measuring instruments that specifically test higher-order thinking skills. Furthermore, the Mathemagics method is often compared to conventional learning such as lectures or drills without considering other approaches that also aim to develop HOTS, such as Problem-Based Learning (PBL) or Discovery Learning. In addition, the application of this method is still limited to basic materials, such as number operations and multiplication (Lucy et al., 2025; R. Siregar & Siregar, 2025), so its effectiveness in improving HOTS on more complex materials has not been widely studied empirically. Previous research also shows that the effectiveness of exploration-based methods is highly dependent on the adaptation of the learning model used (Yu & Zin, 2023). If Mathemagics has aspects of exploration and problem solving, it is necessary to analyze the extent to which this method can be compared with other learning strategies such as Discovery Learning (al Aliyawinata et al., 2021).

This study offers a new contribution by specifically analyzing the effectiveness of the Mathemagics method on students' HOTS problem-solving abilities, not only in terms of improving learning outcomes in general. Unlike previous studies that focused more on learning motivation, understanding basic concepts, and cognitive learning outcomes, this study aims to comprehensively analyze how the Mathemagics method can improve students' high-level thinking skills in solving mathematical problems. In addition, this study uses a more specific HOTS measurement instrument that has been tested for validity and reliability, so that it can provide more accurate findings. Thus, the results of this study are expected to provide a significant contribution in developing innovative and evidence-based mathematics learning strategies in improving students' HOTS.

Research Methods

This study uses a quantitative method with a quasi-experimental design. The quantitative method is based on the philosophy of positivism, which is used to study a certain population or sample with data collection techniques through research instruments and quantitative data analysis to test the established hypothesis (M. P. Sugiyono, 2018). Quasi-experimental research involves two main samples, namely the experimental group that is given treatment and the control group that does not receive treatment (Amalia et al., 2022; Krass, 2016; Thyer, 2012). The population in this study were all students of class VII of SMP Negeri 1 Situbondo.



Picture1. Reseacrh Design

The population is the total number of research subjects to be studied (Ikram et al., 2024). While the sample is part of the population needed by researchers during the study (Omair, 2025). In this study, the sample was selected using a purposive sampling technique with the following criteria: (1) students who have received material in accordance with the application of the Mathemagics method, (2) students with varying levels of ability (*high, medium, low*) to obtain more representative results, and (3) teachers who have experience in teaching mathematics. Two classes were selected as research samples, namely class VII G as the experimental group (30 students) who received learning using the Mathemagics method, and class VII H as the control group (30 students) who received conventional learning. Data collection techniques according to (Sohilait, 2020) are researcher activities in an effort to collect a number of data generated in the field which are used to test a hypothesis.

Data collection techniques in this study consist of tests. There are 10 essay questions used to measure students' higher order thinking skills: (1) Tests, according to Suaidah et al. (2022) are research tools that are specifically used to measure the results of learning in the form of knowledge, skills and knowledge of a person. The tests in this study were used to measure students' HOTS before and after treatment. The test questions were arranged based on HOTS indicators in the revised Bloom's Taxonomy, which include analyzing (C4), evaluating (C5), and creating (C6). Content validity was tested through mathematics education experts and validity test (R-value), while reliability was tested with Cronbach's Alpha to ensure the reliability of the measuring instrument. HOTS-based tests take longer to complete, which can be a challenge for students with low understanding. (2) Questionnaires, according to Suaidah et al. (2022) are research instruments that contain questions or statements related to the indicators that will be used to collect data. In this study, the questionnaire was used to measure students' perceptions of the mathemagics method as well as their motivation and interest in learning mathematics. The questionnaire instrument has gone through construct validity and reliability tests with Cronbach's Alpha, to ensure that the statements in the questionnaire actually measure the aspects being studied consistently. Data analysis techniques according to Sohilait (2020) are a process of processing data that has been collected and then collected by researchers to obtain information so that it is easy to understand.

The data analysis techniques used in this study include descriptive statistics to describe the distribution of pretest and post-test data results of geometry mathematics, as well as normality tests (kolmogorov-smirnov and shapiro-wilk) to ensure data distribution. Furthermore, inferential statistics in the form of paired sample t-test to determine whether there is a significant difference between the pre-test and post-test values in both the experimental and control class. In addition, the N-Gain Test was conducted to measure the extent of the effectiveness of improving learning outcomes before and after treatment from each group/class.

Results and Discussions

As explained previously, this study uses the mathemagic method. The selection of this method is considered very appropriate as an alternative, effective method of joyful learning for junior high school students. The steps of the mathemagic method are as follows: (1). Initial Preparation; At this stage, the teacher opens the lesson and prepares a math game or trick that follows the material to be taught, as an initial motivation for students that mathematics is amazing, interesting, and fun. For example, suppose the math material to be taught is geometry. In this case, the mathemagic chosen is guessing the numbers on the calendar with a geometric shape in the form of a square measuring 2x2, 3x3, or 4x4; (2) Explanation of Tricks/Games: At this stage, the teacher briefly explains how math tricks or games are played in a fun way. This can be done with simple and easy-to-understand examples; (3) Implementation: At this stage, the teacher asks students to try the trick or game. They can be asked to follow the steps that have been explained previously to try to predict the results; (4) Discussion and Analysis: At this stage, the teacher facilitates a discussion to understand the mathematical principles behind the trick. This helps students see how the trick relates to the mathematical concepts they are learning; (5) Repetition; At this stage, the teacher can repeat the trick or game several times and relate it to the material, example, questions or problems that are relevant to the mathematical material to be taught. This helps students to understand the concept and strengthen their understanding; (6) Delivery of Core Material; At this stage, the teacher delivers the core/main material of mathematics that is the learning objective; and (7) Closing; At this stage, the teacher closes or ends the learning in class.

In this section of results and discussion, the research data that has been analyzed using descriptive and inferential statistics assisted by SPSS 25 will be presented in detail. The data from the analysis describe the results of the normality and homogeneity tests of the two research groups/classes, namely the experimental class and the control class. Not only that, the research data also explains the differences in the averages of the two classes and the level of effectiveness of both as evidence that one of the methods (Mathemagic Method) as one of the joyful learning is more effective than the other method (lecture method) as a conventional method.

Descriptive Statistic Results

This research was conducted on students of State Junior High School 1 Situbondo who were divided into two groups/classes, namely the experimental class and the control class, each consisting of 30 students. The following are the results of the descriptive analysis of the results of the pre-test and post-test of the experimental class and the control class.

Table 1. Descriptive Statistics

	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Sum Statistic	Mean		Std. Dev. Statistic	Variance Statistic
						Statistic	Std. Error		
Pre-test of experimental Class	30	15	60	75	2064	68.80	.692	3.791	14.372
Post-test of experimental Class	30	14	80	94	2635	87.83	.633	3.465	12.006
Pre-test of control class	30	10	58	68	1897	63.23	.486	2.661	7.082
Post-test of control class	30	10	68	78	2196	73.20	.478	2.618	6.855
Valid N (listwise)	30								

Based on Table 1.1, descriptive analysis was conducted to evaluate the distribution of data in the experimental and control classes before and after the treatment. In the experimental class/group, the pre-test score ranged from 60–75 with an average of 68.80 (SD = 3.791, Variance = 14.372). After the treatment, the post-test score increased significantly with a range of 80–94 and an average of 87.83 (SD = 3.465, variance = 12.006), indicating the effectiveness of the intervention given. The control class showed a smaller increase, from pre-test with a range of 58–68 and an average of 63.23 (SD =

2.661, variance = 7.082) to post-test with a range of 68–78 and an average of 73.20 (SD = 2.618, variance = 6.855). The difference in improvement between the two groups is quite striking, where the experimental class experienced an average increase of 19.03 points, while the control class experienced only 9.97 points. The standard deviation in the experimental class decreased slightly after treatment, indicating an increase in the consistency of learning outcomes. Thus, these results indicate that the learning method applied to the experimental class is more effective than the control class. Furthermore, a normality test was carried out to determine whether the data were normally distributed or not.

Table 2. Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
HOTS Test Results	Pre-test of experimental class	0.091	30	0.200*	0.974	30	0.641
	Post-test of experimental class	0.086	30	0.200*	0.980	30	0.819
	Pre-test of control class	0.113	30	0.200*	0.968	30	0.475
	Post-test of control class	0.121	30	0.200*	0.969	30	0.514

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on table 1.2, the results of the normality test were carried out using Kolmogorov-Smirnov and Shapiro-Wilk, with a significance level (Sig.) above 0.05 indicating that the data were normally distributed. In the experimental class, the pre-test results showed Kolmogorov-Smirnov (KS) = 0.091, sig. = 0.200 and Shapiro-Wilk (SW) = 0.974, sig. = 0.641, while the post-test results had KS = 0.086, sig. = 0.200 and SW = 0.980, sig. = 0.819. Both of these results indicate that the pre-test and post-test data in the experimental class were normally distributed. In the control class, the pre-test results showed KS = 0.113, sig. = 0.200 and SW = 0.968, sig. = 0.475, while the post-test had KS = 0.121, sig. = 0.200 and SW = 0.969, sig. = 0.514. The p-value greater than 0.05 in both of these test methods indicates that the data in the control class is also normally distributed. Thus, based on the results of this normality test, it can be concluded that the data in this study meets the normal distribution. Then continued the Homogeneity of Variance test which aims to see whether the data from the two groups have the same variance or vice versa.

Table 3. Test of Homogenity of Variance

		Levene Statistic	**df1**	**df2**	**Sig.**
HOTS Test Results	Based on Mean	1.729	1	58	.194
	Based on Median	1.604	1	58	.210
	Based on Median and with adjusted df	1.604	1	50.992	.211
	Based on trimmed mean	1.646	1	58	.205

Based on Table 3, the homogeneity test uses Levene's Test for Equality of Variances which evaluates the equality of variances based on various methods (mean, median, trimmed mean) for the decision-making criteria, namely

1) If Sig. (p-value) ≥ 0.05; The variance of both groups is homogeneous (there is no significant difference in variance).
2) If Sig. (p-value) < 0.05; The variance of both groups is not homogeneous (there is a significant difference in variance).

The results of the interpretation of the data above are: Levene's Test Based on Mean (Sig. = 0.194 > 0.05); Homogeneous group variance), Levene's Test Based on Median (Sig. = 0.210 > 0.05); Homogeneous group variance), Levene's Test Based on Median (adjusted df) (Sig. = 0.211 > 0.05); Homogeneous group variance), Levene's Test is based on a trimmed mean (Sig. = 0.205 > 0.05). Homogeneous group variance. Based on all methods in Levene's Test, the Sig. value is > 0.05, so it can be concluded that the data variance between the experimental and control classes is homogeneous:

Inferential Statistics Results

This inferential statistic is used to statistically test whether the two research groups in the experimental class and the control class have a significant difference in the average value of each pretest and post-test value produced. The following presents the results of the inferential statistical analysis of the two research groups.

Table 4. Paired Samples Test

		Paired Differences					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	Upper			
Group 1	Post-test of experimental class- Pre-test of experimental class	19.033	0.890	0.162	19.366	18.701	117.145	29	0.000
Group 2	Post-test of control class – Pre-test of control class	9.967	0.183	0.033	10.035	9.898	299.000	29	0.000

Based on Table 4, the paired sample test above is used to compare two averages from the same class before and after treatment (pre-test and post-test). The goal is to see if there is a significant change after the treatment is given.

The decision making criteria:

1) If Sig. (2-tailed) ≥ 0.05; There is no significant difference.
2) If Sig. (2-tailed) < 0.05; There is a significant difference between the pre-test and post-test.

The results of the data above show the difference between the pre-test and post-test of the experimental class, namely mean difference (average difference):19.033. The post-test score increased significantly compared to the pre-test, Std. deviation: 0.890 (showing data variation in the experimental class), T-Value (t): 117.145; The t-value is very large, indicating a very strong difference, degrees of freedom (df): 29, Sig. (2-tailed): 0.000 < 0.05); Significant difference between pre-test and post-test of the experimental class. It can be concluded that there is a significant increase in scores after treatment in the experimental class. While the difference between pre-test and post-test of the control class obtained a mean difference (average difference): 9.967. The post-test score increased, but was smaller than the experimental class, Std. Deviation: 0.183 (indicating data variation in the control class), t-value: 299.00, a very large t-value, indicating a strong difference, degrees of freedom (df): 29, Sig. (2-tailed): 0.000 < 0.05). Significant difference between pre-test and post-test of the control class, it can be concluded that there was a significant increase in the control class's score, but this increase was smaller than the experimental class.

The Result of N-Gain Category and Interpretation

From the data above, it can be concluded that both the experimental class and the control class experienced a significant increase in post-test scores compared to the pre-test (Sig. = 0.000), the increase in scores in the experimental class was much greater (19.033) than the control class (9.967), indicating that the treatment given to the experimental class was more effective. This significant difference is supported by a very large t value, indicating that the change in score was not just a coincidence. The implication is that the treatment given to the experimental group proved to be more effective in improving post-test results than the control group. Then to measure the effectiveness of improving learning outcomes before and after treatment, an analysis was used in the form of an N-Gain test, this value is expressed in percentage (%) and shows how much the results increased after the treatment was given. The following is a table of N-Gain test results.

Table 5. Descriptives Statistic of N-Gain Result

Groups				Statistic	Std. Error
NGain_Persen	Experimental Class	Mean		61.7142	1.21392
		95% Confidence Interval for Mean	Lower Bound	59.2315	
			Upper Bound	64.1969	
		5% Trimmed Mean		61.5990	
		Median		60.0000	
		Variance		44.208	
		Std. Deviation		6.64889	
		Minimum		50.00	
		Maximum		76.00	
		Range		26.00	
		Interquartile Range		11.61	
		Skewness		0.244	0.427

Groups			Statistic	Std. Error
	Kurtosis		-0.687	0.833
Control Class	Mean		27.2364	0.34852
	95% Confidence Interval for Mean	Lower Bound	26.5236	
		Upper Bound	27.9492	
	5% Trimmed Mean		27.2106	
	Median		27.0270	
	Variance		3.644	
	Std. Deviation		1.90892	
	Minimum		23.81	
	Maximum		31.25	
	Range		7.44	
	Interquartile Range		2.93	
	Skewness		0.249	0.427
	Kurtosis		-0.705	0.833

Table 6. N-Gain Percentage Result

Groups	**Mean N-Gain (%)**	**Minimum**	**Maximum**
Experimental Class	61.71%	50.00%	70.00%
Control Class	27.24%	23.81%	31.25%

Table 7. The Effectiveness of N-Gain Category Interpretation

Percentage	**Category Interpretation**
<40	Ineffective
40-55	Les effective
56-75	Quite Effective
>76	Effective

Based on the interpretation Table, it is known that the experimental class has an average N-Gain of 61.71%, which is in the quite effective category. This shows that the method or treatment given to the experimental class/group is quite effective in improving students' High Order Thinking Skills, both at the level of analyzing, evaluating, and creating. Meanwhile, the control class only obtained an N-Gain of 27.24%, which is in the low category. This shows that the conventional method used in the control class is not effective in improving students' high-order thinking skills compared to the experimental class.

The results of the study indicate that the application of mathemagic as an alternative joyful learning method is quite effective in mathematics learning in junior high schools compared to the conventional lecture method. As is known, the difference in the average pretest (68.80) and posttest (87.83) scores in the experimental class is 19.03. This shows that the application of mathemagic as an alternative joyful learning method has succeeded in increasing students' HOTS results by 19.03 points. Meanwhile, the average pretest (63.23) and posttest (73.20) scores in the control class were 9.97. This indicates that the lecture method has succeeded in increasing students' HOTS results by 9.97 points. From the average increase in the two class/groups, it is clearly known that mathemagic as an alternative joyful learning method has an increase of 19.03 points greater than the increase in lectures as a conventional method. Both differences in average increases are significant. This is based on the results of the paired sample t-test which showed a significance value of t (sig.t 0.000) less than 0.05, both in the experimental class and in the control class.

This finding indicates that the treatment given had a significant impact on increasing HOTS of students at state junior high school 1 Situbondo. Overall, the results of the study illustrate that the application of mathemagics as an alternative joyful learning method is quite effective in mathematics learning compared to conventional lecture methods, so it is more appropriate to be used as a complement than the main method in HOTS learning (Ramadhana et al., 2025). Previous research has shown that Problem-Based Learning (PBL) and Discovery Learning (DL) have higher effectiveness (N-Gain> 70%) in improving students' HOTS (Ramadhani & Haryani, 2023; Siregar & Surya, 2017; Yudisthira et al., 2024). In addition, the application of PBL assisted by Wordwall has been shown to increase understanding and problem solving by up to 80.27% (Mudrika et al., 2024). Thus, the Mathemagics method is more effective as a supporting strategy than as the main approach in improving students' HOTS.

The results of this study are relevant to the study Astindari et al. (2023) which shows that the Mathemagics method creates a more enjoyable learning atmosphere and increases student motivation. Research Wahyunita (2017) also confirms that this method contributes to improving mathematical reasoning skills, especially related to learning motivation. In addition, this study has similarities with the study Sari (2021). which emphasizes the development of HOTS-based mathematics problems to improve students' critical thinking. The study Lin et al. (2020) also supports that emotional experiences in mathematics learning affect conceptual understanding and learning outcomes. This finding is reinforced by Maswar (2019) who developed a mathematics learning strategy based on Mathemagics games, puzzles, and mathematical stories to increase students' interest in learning. Thus, innovative approaches such as Mathemagics are an attractive alternative in improving critical thinking and problem-solving skills (Yu & Zin, 2023).

Students who follow geometry learning by applying the mathemagic method are quite active in asking questions and providing responses during the delivery of this geometry mathematics material. Through learning conditions like this, teaching and learning activities in the classroom do not look boring and monotonous, so it can be said that participants enjoy and are happy and have a positive perception of mathematics, especially when given a game or mathematical magic to guess numbers on a 3x3 square calendar as motivation. This is in line with the opinion of Siregar and Surya (2017), who said that students' learning motivation will increase after being given treatment by applying the mathmagic method, or in other words, the mathmagic method is effectively used in mathematics lessons (Pasangka et al., 2020).

However, this study also confirms that Mathemagics needs to be combined with exploration-based strategies for more optimal HOTS results, as shown in the Discovery Learning and PBL studies (al Aliyawinata et al., 2021; Mudrika et al., 2024). Further research can explore the integration of interactive technologies, such as Wordwall or other digital media, to increase the effectiveness of Mathemagics in learning (Mardi et al., 2021).

Conclusions and Suggestions

This study shows that the application of mathemagics as an alternative joyful method is quite effective and significant in mathematics learning compared to lectures as a conventional method in improving HOTS of students at State Junior High School 1 Situbondo. This evidence can be seen from the average increase of 19.03 points for the experimental class using the mathemagics method in geometry material, while in the control class with the lecture method it was only 9.23 points, with a significance value of paired sample t-test of 0.000 less than 0.05. Other evidence, the results of the N-Gain test showed that the increase in HOTS in the experimental class reached 61.71% in the quite effective category, while in the control class it was only 27.24% in the ineffective category. Overall, the mathemagics method can be an alternative method in joyful learning of math to improve students' HOTS.

The mathemagics method is integrated into the mathematics learning curriculum to improve students' High Order Thinking Skills (HOTS). This method needs to be further developed so that it can be applied to more complex mathematical concepts. In order for learning outcomes to be more optimal, the mathemagics method should be combined with a problem-based approach, such as problem-based learning or discovery learning. To support effective implementation, training is needed for teachers so that they can apply this method well in the classroom. With this recommendation, it is hoped that mathematics learning will be more creative, innovative, interesting, effective and solution-oriented in improving learning outcomes and students' thinking skills.

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