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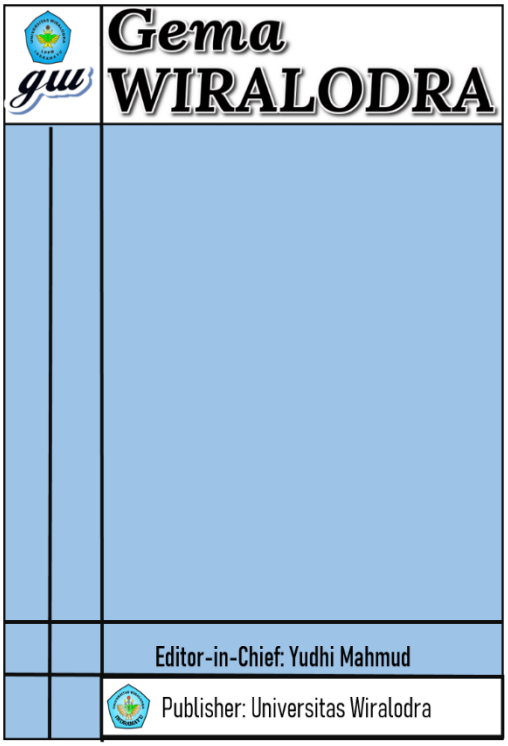

Critical review: the effectiveness of student teams-achievement divisions vs numbered heads together cooperative learning in improving students' mathematical critical thinking abilities

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Critical review: the effectiveness of student teams-achievement divisions vs numbered heads together cooperative learning in improving students' mathematical critical thinking abilities

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Abstract
This research aims to analyze the differences in critical mathematical thinking abilities who receive cooperative learning in the Student Teams-Achievement Divisions (STAD) type and those who undertake the cooperative learning process in the Numbered Head Together (NHT) type. This research design uses a quasi-experimental design. Apart from that, the population in this study were all students of the Taliwang State 1 Middle School West Sumbawa, while the sample was taken in two classes randomly from 18 existing classes (class VIII 3 and class VIII 4). Experimental class 1 consists of 32 people, while experimental class 2 consists of 32 people, so the total is 64 people. Data obtained from thinking ability tests were analyzed univariately, bivariate, and multivariate. The results of the univariate analysis show that the majority of respondents in Experiment 1 were male, 16 females, 16 people each (50%), the majority were of medium ability, 21 people (65.6%), then the High category was 7 people (22%) and the low category as many as 4 people (12.5%), while the majority of respondents in Experiment 2 were 17 people (53.1%) women while 15 people (47%) were men with 17 people (53.1%) in the medium category. High 9 people (28.1% and Low category 6 people (18.7%). Furthermore, the results of bivariate analysis showed that there were differences in students' mathematical critical thinking abilities between experimental class 1 and experimental class 2, while the significant value for the group category was 0.007, this means that there are differences in students' mathematical critical thinking abilities based on the categories of high, medium and low ability students. The results of the multivariate analysis show that the mathematical critical thinking abilities of students who received STAD-. type cooperative learning has a higher increase than students who receive NHT-type cooperative learning.
Keywords: Student Teams-achievement Divisions, Numbered Head Together, Mathematical Critical Thinking Ability

1. Introduction
Mathematics education has long been recognized as an important foundation in the development of students' critical thinking abilities. Mathematical critical thinking skills not only enable students to understand mathematical concepts in depth, but also help them develop analytical, logical, and problem-solving skills that are relevant in various life contexts (Peter, 2012). In an era where information is easily accessible through technology, the ability to carefully review, interpret, and evaluate information has become increasingly important. Therefore, it is important to integrate mathematical critical thinking learning into the educational curriculum (Sezer, 2008; Cáceres et al., 2020).

One approach that has become the main focus in promoting critical mathematical thinking skills is cooperative learning (Catarino et al., 2019; Siagian et al., 2023; Sriyani et al., 2019). Cooperative learning places students in an active role, fosters collaboration between students, and encourages them to learn from each other and exchange ideas

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(Ismunandar et al., 2020; Agustin et al., 2020). Two cooperative learning models commonly considered are Student teams-achievement divisions (STAD) and Numbered Head Together (NHT).

However, even though these two models have been widely used in various educational contexts, there is still a need to critically review their effectiveness in developing students' mathematical critical thinking abilities. It is hoped that this review will provide a deeper understanding of the strengths and weaknesses of each model so that educators can make informed decisions in choosing the most appropriate learning approach for their context. By enriching our understanding of how cooperative learning can be used effectively to improve critical mathematical thinking skills (Sadeghi, 2019). It is hoped that this research can make a significant contribution to efforts to improve the quality of mathematics education at the school level (Sadeghi, 2019; Novianti et al., 2021). In addition, by considering the global implications of critical mathematical thinking skills in the era of technology and globalization, this research also has broader relevance in preparing students to face complex challenges in an ever-present era. changing and developing society.

Furthermore, through this critical review, it is hoped that it can provide a deeper understanding of the advantages and disadvantages of each cooperative learning model, as well as provide practical guidance for educators in choosing the most appropriate learning model to improve students' mathematical critical thinking abilities. Thus, it is hoped that this research can provide a valuable contribution to efforts to improve the quality of mathematics education at the school level.

2. Method

This research adopts a quasi-experimental design due to its practicality and relevance in assessing educational interventions in real-world settings. The study population encompasses all students enrolled at Taliwang State 1 Middle School in West Sumbawa. From this population, a sample was randomly drawn from the available 18 classes, specifically selecting participants from Class VIII 3 and Class VIII 4. Each experimental group, designated as Experimental Class 1 and Experimental Class 2, comprised 32 students, resulting in a total sample size of 64 participants.

The primary focus of data collection revolves around evaluating students' thinking abilities through standardized tests tailored to measure critical thinking within mathematical contexts. These data undergo comprehensive analysis using various statistical techniques, including univariate, bivariate, and multivariate analyses. Univariate analysis provides insights into the distribution and characteristics of individual variables. Bivariate analysis explores the relationship between two variables, allowing researchers to assess the intervention's impact on students' thinking abilities while considering potential confounding factors. Finally, multivariate analysis offers a nuanced examination of the interplay between multiple variables, facilitating a deeper understanding of the factors influencing students' critical thinking development within the context of cooperative learning methodologies.

Through this rigorous analytical approach, the research aims to derive robust conclusions regarding the comparative effectiveness of STAD and NHT cooperative learning models in enhancing students' mathematical critical thinking skills. By employing quasi-experimental methods and rigorous statistical analyses, the study seeks to provide valuable insights into the practical implications of cooperative learning strategies for promoting critical thinking abilities among middle school students.

3. Findings Research and Discussion

Description Subject Study

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Subject study This is student class class VIII-3 and class VIII-4 of SMP Negeri 1 Taliwang. Student class VIII-3 is assigned as experimental class and class VIII-4 as experimental class -2. Each class totals 32 students with details in Table 1.

Table 1
Amount Subject Study

	Class -1		Class -2	
	Amount	Percentage	Amount	Percentage
Man	16	50.00%	15	46.87%
Woman	16	50.00%	17	53.13%
Amount	32	100%	32	100%

Based on Table 1, it is known that composition students in experimental class -1 based on type her gender-balanced or The same between amount students man with amount student Woman. Meanwhile, in experimental class -2, the number of student Women was a little more lots compared to with amount of student men.

Description of Pre-Test Results

Pre-tests used to know the extent to the material or material lesson to be taught can mastered by students so that can make one reference to what is being compared? in the experiment This point departure over two groups comparison relatively No Far different competence or no and whether There is enhancement competence or on the contrary Later in the learning process of the two learning models in question in study this. The results from the pre-test in question can see in the table following.

Table 2
Test Results

	Experiment-1	Experiment-2
Amount	571.76	563.65
Average	17.87	17.61
The highest score	52.39	23.20
Lowest Value	8.63	8.63

Based on Table 2, known that pre-test achievement in experimental class -1 was higher compared to achievement in experimental class -2. This matter can be seen in the average score obtained. In experimental cla ıe average score obtained was 17.87, while in experiment 2 it was 17.61.

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Test Results

The aim of the post-test is given know is all material lessons already mastered as best as possible by students so that the post-test is done after treatment in an experiment. The results from the posttest in question can be seen in Table 3.

Table 3
Test Results

	Experiment-1	Experiment-2
Amount	2018.18	2116.44
Average	63.07	66.14
The highest score	100.00	100.00
Lowest Value	30.20	34.09

Based on 3, it is known that post-test achievement in experimental class-2 was Good compared to achievement in experimental class -1. This matter can be seen in the average

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score obtained. In experimental class -2, the average score obtained was 66.14, while in experiment 2 it was 63.07.

Normality test

The normality test is used to know if population data is normally distributed or No. The statistical test used in the normality test is *the Kolmogorov -Smirnov* test with a criteria level significance of 5% (0.050). Data stated is normally distributed if the significance is bigger than 5% or 0.050. Test result normality via the *SPSS version 20 for Windows* program can be seen in Table 4.

Table 4

Summary of Normality Test Results

No	Variable	Statistics	Df	Sig.	Note.
1	Pretest -1	.281	32	.083	Normal
2	Posttest -1	.161	32	.064	Normal
3	Gains Score Experimental Class-1	.129	32	.188	Normal
4	Pretest -2	.189	32	.065	Normal
5	Posttest -2	.162	32	.063	Normal
6	Gains Score Experimental Class-2	.151	32	.062	Normal

From Table 4 above, it can be known that data pretest, posttest, gains score experimental class -1 and pre-test, post-test, gains score class 2 consecutive experiments own mark significance amounted to 0.083; 0.064; 0.188; 0.065; 0.063; 0.062. Based on mark probability obtained bigger from level significance α = 0.050, then concluded distributed data that pretest, post-test, gains score data experimental class -1 and experimental class -2 had a normal distribution.

Homogeneity Test

The homogeneity test is intended to show that two or more sample data groups originate from a population that has the same variance. The statistical test used in the homogeneity test is *Levene's* Test. As criteria testing, the data will say homogeneous if its sig value. > 0.050. As for the results testing for data on classes control and experiment can be shown in Table 5.

Table 5

Summary of Homogeneity Test Results

	Levene Statistics	df1	df2	Sig.	Information
Pretest Learning Results	,313	1	62	,578	Homogeneous
Posttest Learning outcomes	,075	1	62	,785	Homogeneous
Gains Score	,681	1	62	,412	Homogeneous

Based on Table 5, it is known that the mark significance variable is bigger than 0.050. This matter shows that variants between data groups are not different or homogeneous, so can concluded that conditions in experimental class -1 and experimental class -2 have the same variant.

Hypothesis testing

For testing to hypotheses, second, third, and fourth so the two-way ANOVA test was used. The test results can see in the table following.

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Table 6
Grouping Amount Subject

		Value Labels	N
Class	1.00	Experiment-1	32
	2.00	Experiment-2	32
Group	1.00	Tall	15
	2.00	Currently	35
	3.00	Low	14

Based on Table 6 it can be known that amount subjects in each class is the same, namely 32 people. Of the total 64 subjects, 15 were in the " high " group, 35 people in the "medium" group, and 14 people in the “low” group. This matter can conclude that, a partly big subject study including the “medium” group. Test results to differentiate the abilities of each group can be seen in Table 7.

Table 7
Test result Difference Ability Think Critical Mathematical between Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5409,064 [a]	5	1081,813	4,494	,002
Intercept	111070,755	1	111070,755	461,404	,000
Class	199,528	1	199,528	,829	,036
Group	2614,091	2	1307,045	5,430	,007
Class * Group	3424,007	2	1712,003	7,112	,002
Error	13961,950	62	240,723		
Total	159922,898	64			
Corrected Total	19371,013	63			

Based on 7, it is known that the mark significance for the category class is 0.036. This matter can be interpreted that there is a difference ability to think critically mathematical students between experimental class -1 with experimental class -2. Whereas the mark significance for the category group is 0.007. It means that there is different ability think critical mathematical student based on the category student capable high, medium, and low. As for the differences ability think critical mathematical students can see in Table 8.

Table 8
Difference Ability Think Critical Mathematical Student

Group	Average Grade/ Class	
	Experiment-1	Experiment-2
Tall	65.59	46.52
Currently	43.32	49.24
Low	24.18	49.10
Total	45.20	48.52

Based on the table above, can is known that the ability to think critically of mathematical students in experimental class -1 is Better compared to those in experimental class -2. This matter showed with difference in average increase results between classes. In the experimental class -1 the average was 45.20, whereas experiment class -2 was 48.52.

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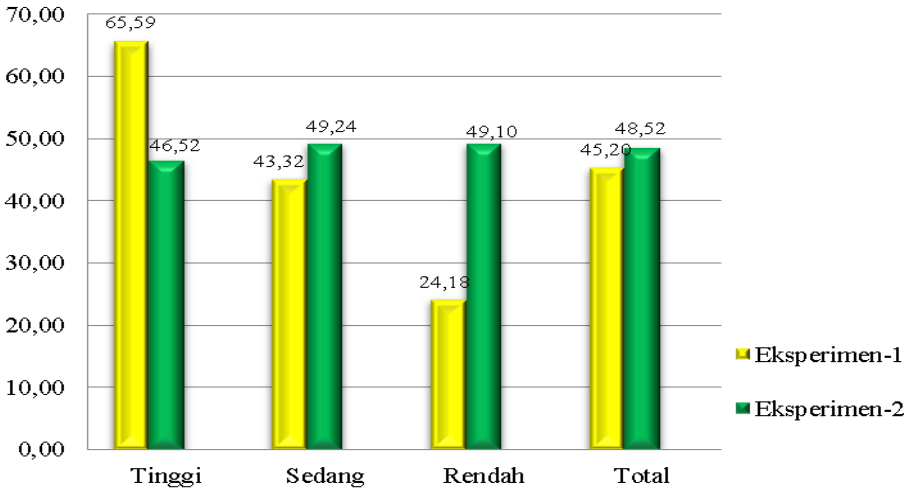
Figure 1
Difference Ability Think Critical Mathematical



For proof hypotheses first and fifth, use the independent samples t-test. Analysis results Output Group Statistics from gains score results Study experimental class -1 with experimental class -2 can see in Table 9.

Table 9
Group Statistics Test Results

	Class	N	Mean	Std.	Std.
Mark	Experiment	32	45,201	18.82005	3.32695
	Experiment	32	48.524	16.27813	2.87759

Based on Table 9, it can be seen that the number (N) of students in each class is 32 students. The average gains score (mean) in experimental class 1 was 45.20 while in experimental class 2 it was 48.52. This shows that the mean gains score of experimental class-2 is higher compared to experimental class-1. A Detailed summary of the results of the independent samples t-test on the gains score for mathematical critical thinking abilities among students is in Table 10.

Table 10
Summary of Class Difference Test Results Experiment-1 and Experiment-2

			Equal variances assumed
Levene's Test for Equality of Variations	F		,681
	Sig		,412
t-test for Equality of Means	t		,755
	df		62
	Sig. (2-tailed)		,045
	Mean Difference		3.23313
	95% Confidence Interval of The Difference	Lower	-11.11613
		Upper	5.46988

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Based on Table 10 noted that the significance value is greater than the significance value = 0.412 > α = 0.050, this means the ability data the mathematical critical thinking of the experimental class-1 and experimental class-2 groups had variations homogeneous. Therefore, the t-test results use *equal variance assumed*. Apart from that, from Table 10 it is also known that the Sig. = 0.0 45 < α = 0.050, then Ho is dotilak. This means that there is a difference in the ability to improve significant mathematical critical thinking between experimental class-1 students and experimental class-2 students. The calculated t value (0.755) is positive, with a mean difference *of* 3.23. This shows that the average learning outcomes in experimental class-2 are higher than experimental class -2. Based on the results of this analysis, it can be concluded that the hypothesis which states " the mathematical critical thinking ability of students who receive STAD type cooperative learning is higher than students who receive NHT type cooperative learning " and "there are differences in increasing mathematical critical thinking skills between students who received STAD and students who received "NHT Type Cooperative learning " can be proven.

Discussion

In Experiment Group I, participants were treated with the cooperative learning model known as STAD (Student teams-achievement divisions). The implementation of this model involved several stages: the teacher explained the material, organized participants into study groups using the method of sharing classes, consisting of 4-5 children per group, administered quizzes, and awarded prizes at the end of each session. During STAD-type cooperative learning sessions, participants were actively engaged in their learning. This was evident from their enthusiasm in completing assignments and engaging in discussions. Following discussions, students eagerly presented their findings to the class, with other groups responding, leading to collaborative conclusions with the teacher. Participants were encouraged to work together as tasks were designed to require group collaboration. Active participation was rewarded to foster continued engagement. Through quizzes at the end of sessions, participants were encouraged to attempt all questions, promoting a more enterprising approach to learning.

In Experiment Group II, participants were exposed to the cooperative learning model NHT (Numbered Head Together). While participants were generally active during sessions, some remained passive, relying solely on their peers for answers without individual effort. Despite this, overall enthusiasm for learning remained high throughout the study.

Based on research findings, students in Experiment Group II, exposed to the STAD model, exhibited better problem-solving abilities compared to those in Experiment Group I, exposed to the NHT model. This suggests that the STAD model is more effective in enhancing students' mathematical critical thinking abilities. The difference in outcomes can be attributed to the higher level of engagement and understanding among participants in Experiment Group II. In this group, students not only focused on their knowledge but also took responsibility for their peers' learning. Accountability within groups ensured a comprehensive understanding of the material, motivating students to actively participate and strive for excellence. Conversely, in Experiment Group I, where the NHT model was used, many participants lacked engagement in group work, possibly due to the individualistic approach to presenting answers.

In conclusion, despite efforts to implement the study effectively, various challenges were encountered, including insufficient preparation, lack of educational support, and suboptimal classroom management. Nonetheless, the research highlights the importance of cooperative learning models, particularly the STAD approach, in promoting active engagement and enhancing critical thinking skills among middle school students. To improve outcomes, teachers and researchers should focus on meticulous planning, effective

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instructional techniques, and robust implementation strategies tailored to the chosen learning models.

4. Conclusion

The bivariate analysis results revealed notable disparities in students' mathematical critical thinking abilities between Experimental Class 1 and Experimental Class 2. With a significant value of 0.007 for the group category, the analysis indicates significant differences in mathematical critical thinking abilities based on students' proficiency levels —whether categorized as high, medium, or low ability. This underscores the impact of the instructional method on enhancing critical thinking skills across diverse student groups.

Moreover, the multivariate analysis of outcomes offers further insights into the effectiveness of different cooperative learning approaches. Specifically, students exposed to the student teams-achievement divisions (STAD) cooperative learning model demonstrated a more substantial improvement in mathematical critical thinking abilities compared to their counterparts undergoing the Numbered Head Together (NHT) cooperative learning approach. This finding suggests that the collaborative and team-based nature of STAD fosters a more conducive learning environment for enhancing critical thinking skills in mathematics.

Overall, these findings underscore the significance of instructional methods in shaping students' critical thinking abilities and highlight the potential benefits of implementing cooperative learning strategies, particularly the STAD model, in mathematics education. By elucidating the differential impacts of various instructional approaches, this research contributes valuable insights to educational practitioners and policymakers seeking to optimize pedagogical strategies for fostering critical thinking skills among students.

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