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The Influence of the STAD and NHT Learning Models on Students' Cognitive Achievement and Learning Motivation on Colloid Material in Banyumas

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ABSTRAK

Penelitian ini bertujuan untuk menentukan pengaruh model pembelajaran Student Team Achievement Division (STAD) dan Numbered Head Together (NHT) terhadap prestasi kognitif dan motivasi belajar siswa pada materi koloid di MA Negeri 1 Banyumas. Penelitian ini menerapkan pendekatan kuantitatif dengan desain kuasi eksperimen yang melibatkan siswa dari enam kelas XI IPA MA Negeri 1 Banyumas. Kelompok eksperimen pertama diberikan perlakuan menggunakan model STAD, sementara kelompok eksperimen kedua menggunakan model NHT. Teknik pengambilan sampel menggunakan random sampling. Instrumen yang digunakan meliputi tes pilihan ganda untuk mengukur prestasi kognitif dan motivasi belajar. Analisis data menggunakan uji t-test independen. Hasil menunjukkan bahwa model pembelajaran STAD dan NHT berpengaruh secara signifikan terhadap prestasi kognitif dan motivasi belajar siswa pada materi koloid. Nilai p-value untuk model pembelajaran NHT masing-masing adalah 0,47 dan 0,39, sedangkan untuk model pembelajaran STAD adalah 0,17 dan 0,16.

ABSTRACT

This study aims to assess the impact of the Student Team Achievement Division (STAD) and Numbered Head Together (NHT) learning models on students' cognitive achievement and learning motivation in colloidal material at MA Negeri 1 Banyumas. The study uses a quantitative approach with a quasi-experimental design, involving students from six XI science classes of MA Negeri 1 Banyumas. The first experimental group was taught using the STAD model, while the second group was taught using the NHT model. The sampling technique used was random sampling. Instruments included multiple-choice tests to measure cognitive achievement and learning motivation. Data analysis was carried out using an independent t-test. The results showed that both the STAD and NHT models had a significant impact on students' cognitive achievement and learning motivation in colloid material. The p-values for the NHT learning model were 0.47 and 0.39, while the p-values for the STAD learning model were 0.17 and 0.16.

1. INTRODUCTION

One strategy to assess the success of the learning instruction is by examining student learning achievements. These outcomes serve as a benchmark for determining student achievement, and strong learning outcomes suggest that the learning process is functioning effectively, reflecting the overall quality of education. Students can observe their development across cognitive, affective and psychomotor domains. If a student meets the minimum competency standards, they are considered to have passed the terms of cognitive learning outcomes. Various factors, such as instructors, students, facilities, infrastructure, and the environment, influence student learning outcomes (Tokan & Imaculata, 2019). Furthermore, teachers' awareness of scientific principles is crucial; inadequacies in this area can lead to misconceptions among students, thereby negatively affecting their learning outcomes (Kaya & Emre, 2020). In addition, the professional development of teachers is also essential, as it enhances their instructional strategies and ability to create a supportive learning environment (Setyaningsih & Suchyadi, 2021).

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Chemistry can be understood as both a process and a product. Effective chemistry learning should incorporate the concepts and processes inherent in this field. As a product, chemistry comprises a body of knowledge that includes facts, concepts, and chemical principles. As a process, it encompasses the attitudes and skills that scientists employ to gather and develop new information (Saputro et al., 2021). Observations with chemistry teachers at MA Negeri 1 Banyumas indicate that students in class XI continue to experience difficulties with chemistry material. This is evident from the Odd Semester scores for the 2020/2021 Academic Year, where many students failed to reach the minimum competency standard of 70; approximately 60% of students achieved this standard, while 40% did not. Additionally, regarding colloid material in the 2019/2020 Academic Year, about 50% of students failed to reach the minimum competency standard.

Teachers reported that students lack sufficient motivation to engage with chemistry lessons, particularly in colloid system material. They noted that students did not participate actively in the instructional process, leading to low motivation for learning about colloid systems. The strategy employed by teachers for this material combines a direct learning model with the lecture method. Furthermore, a survey conducted among twenty students revealed that 70% found chemistry to be a difficult subject due to numerous concepts that needed to be remembered and their relevance to everyday life. In addition, students reported poor cooperation during chemistry study sessions, contributing to a decline in their motivation to learn.

Based on the description above, the instructional process needs to be improved. The application of learning models relevant to the subject matter being studied is an important factor that influences the success of the instructional process. Selecting the appropriate educational approach can lead to effective teaching. Encouraging and facilitating interaction between students, as well as between teachers and students, is one strategy that can be implemented. Wahyuningsih (2020) states that teachers can use learning models to promote effective interaction among students. Experts have developed cooperative learning models as an alternative to enhance the quality of learning, shifting from a teacher-centered approach to a student-centered one (Silalahi & Hutauruk, 2020).

There are many cooperative learning models that assist students overcome challenges in chemistry. These models assist students who struggle to solve problems by enabling them to learn from more advanced peers. The Student Team Achievement Division (STAD) and Numbered Head Together (NHT) are two distinct cooperative learning models. STAD is considered the simplest and most ideal model for teachers new to the cooperative approach (Damopolii & Rahman, 2019; Syakur & Sabat, 2020). In Slavin's learning model, students are divided into small, heterogeneous groups (Basyah et al., 2021; Nazari et al., 2022). Students engage in group activities or quizzes, the teacher provides material, and students are rewarded for their achievements. This learning model is created to instill the concept of cooperation among students. Ardiyansyah et al. (2019) reported that XI grade science students at SMAN 7 Mataram who utilized the STAD model, supplemented with the student worksheets, exhibited better chemistry learning outcomes. Additionally, a study by Malino (2019) showed that students' chemistry learning outcomes improved significantly using this learning model. Furthermore, research by Erly (2020) indicated that students' motivation to learn was positively influenced when the STAD model was applied to the topics of redox and electrochemical reactions.

The NHT model is developed to stimulate students to participate more actively in the instructional process and to take full responsibility for their grasp of the content, both in groups and individually (Firman et al., 2021; Widyaningtyas et al., 2018; Zahara et al., 2020). Developed by Kagan, NHT involves students reviewing the material covered in a lesson, with four key steps: numbering, questioning, heads together, and answering (Vostal et al., 2023). This cooperative learning model requires active participation from all students, not just those who are academically inclined; it also motivates passive students to engage (Naibaho, 2019; Pinontoan & Pinontoan, 2019).

A study by Hidanurhayati et al. (2018) indicates a connection between student learning achievement at Idhata High School in Bengkulu City and the NHT learning model, along with smart card media. Additionally, research by Rukiah and Yuliza (2019) shows that using the NHT model in conjunction with *PowerPoint* media in experimental classes has a significant positive impact on students' interest in chemistry and their learning outcomes. Furthermore, Ertin et al. (2021) found improvements in cognitive learning outcomes and student activity in biodiversity material.

The motivation of students to learn chemistry is a multifaceted issue influenced by various factors, including teaching methods and the relevance of chemistry to students' lives. Research indicates that effective teaching strategies, such as the integration of modern learning technologies and inquiry-based approaches, can significantly enhance students' motivation to engage with chemistry content. For instance, Huda and Rohaeti (2023) emphasize the importance of utilizing augmented reality, virtual reality, and gamification to make chemistry lessons more appealing to students, thereby increasing their motivation to learn. Similarly, Lin and Wu (2021) found that different instructional methods, particularly those that incorporate visualizations, positively impact both students' conceptual knowledge and their motivation for learning chemistry.

Despite significant research on cooperative learning models, there are still gaps in understanding which specific models are most effective in improving both student learning outcomes and motivation in chemistry. While studies have shown that STAD and NHT can positively impact students' chemistry performance and engagement, there is limited comparative research that directly examines which model performs better under different conditions, such as varying student abilities or content complexity. Additionally, the existing literature lacks a comprehensive analysis of how these models influence long-term student motivation and their ability to foster sustained interest in chemistry.

At first glance, the NHT and STAD learning models may appear different. However, they share a common feature: both models emphasize activities where students work together and collaborate. Research on the various benefits of both learning models indicates that they are both scientifically effective, which highlights the importance for teachers to choose the most suitable model for their classrooms. This study aims to address the research gap by implementing both STAD and NHT in high school chemistry classrooms and comparing their effects on student cognitive achievement and motivation.

2. METHOD

This research is classified as quasi-experimental, utilizing two classes for its implementation. In the first experimental class, the researcher employed the STAD model, while the second experimental class utilized the NHT model. The population comprised students from MA Negeri 1 Banyumas, including class XI Science 1 (29 students), XI Science 2 (34 students), XI Science 3 (34 students), XI Science 4 (33 students), XI Science 5 (35 students), and XI Science 6 (35 students). Sampling for each class was conducted through a lottery process (random sampling), which helps minimize subjectivity in the sampling procedure. Consequently, 35 students from class XI Science 5 were assigned to experimental group 1 (STAD model), while 34 students from class XI Science 2 were assigned to experimental group 2 (NHT model). The instruments used in this research included multiple-choice test questions to collect pre- and post-test data on cognitive achievement, as well as questionnaires to measure student learning motivation. Both instruments were validated prior to being used in the experimental classes.

The validity test, according to Sugiyono (2017), indicates how accurately the actual data about the object reflects the data collected by the researcher. This study employed content and construct validity to determine its validity. The calculation of instrument validity is based on a comparison between the calculated r and the r table, where r table = 0.367 (for df = N-2, 29-2 = 27 at $\alpha = 0.05$). Before proceeding to the t-test, certain requirements must be met, including that the data analyzed must have a normal distribution. To verify this, normality tests and homogeneity tests are necessary (Arikunto, 2019). The normality test evaluates whether the distribution of the data to be analyzed is normal. Testing is conducted based on the variables being processed. The normality of data distribution was assessed using the Shapiro-Wilk test with the assistance of SPSS 23 for *Windows*. If the p-value is ≥ 0.05, the data is considered normal; conversely, if the analysis results show a p-value < 0.05, the data is deemed not normal. In addition to testing the distribution of the analyzed values, a homogeneity test is essential to ensure that the groups forming the sample originate from a homogeneous population. The homogeneity assessment was conducted using the ANOVA test; if the analysis results indicate a p-value ≥ 0.05, the data is considered homogeneous. If the results show a p-value < 0.05, the data is classified as not homogeneous (Sugiyono, 2017).

The research data were evaluated using paired sample tests and independent sample t-tests. The guidelines for comparing the calculated t-test with the table t-test are as follows: (a) if the calculated t-test value ≥ table t-test value, it indicates that the difference is significant, and (b) if the calculated t-test value < table t-test value, it means that the difference is not significant. The cognitive learning outcomes of students who received treatment were measured through the normalized gain test (N-Gain). This increase is obtained from the average score of students before and after the test. N-Gain compares the actual gain score to the maximum gain score. The maximum gain score represents the highest attainable gain a student can achieve, while the actual gain score reflects the gain score obtained by the student (Ilhamdi et al., 2020).

3. RESULTS AND DISCUSSION

Results

Data processing and analysis are necessary to determine students' cognitive achievements on colloidal material before and after model implementation. The aim of the pre-test is to assess students' cognitive achievement in the initial colloidal material, while the post-test evaluates students' achievement in the final colloidal material. Both groups involved in this study were administered tests. The recapitulation can be found in Table 1.

Table 1. Average Cognitive Achievement Scores on Pre-test and Post-test for Colloidal Material in STAD and NHT Model Groups

Description	STAD Model		NHT Model	
	Pre-test	Post-test	Pre-test	Post-test
N	35	35	34	34
Mean	52.76	60.95	52.74	75.10
Median	53.33	60.00	53.30	73.33
Mode	53.33	60.00	53.30	73.33
Standard Deviation	7.12	6.50	7.22	7.92
Minimum	40.00	53.33	40.00	60.00
Maximum	66.67	80.00	66.70	86.67
Sum	1846.66	2133.32	1793.30	2553.34

Table 1 summarizes the average pre-test scores for the STAD and NHT models are 52.76 and 52.74, respectively. Meanwhile, the average post-test scores for these groups are 60.95 and 75.10, respectively. This indicates an improvement in cognitive performance related to colloidal materials.

Additionally, Table 2 displays a summary of the learning motivation scores for the pre-test and post-test on colloidal material for both the STAD and NHT model groups.

Table 2. Average Learning Motivation Scores on Pre-test and Post-test for Colloidal Material in STAD and NHT Model Groups

Description	STAD Model		NHT Model	
	Pre-test	Post-test	Pre-test	Post-test
N	35	35	34	34
Mean	56.94	63.97	56.91	73.65
Median	56.00	64.00	54.50	73.00
Mode	56.00	61.00	54.00	71.00
Standard Deviation	5.21	4.40	6.17	5.88
Minimum	50.00	57.00	50.00	62.00
Maximum	69.00	71.00	69.00	86.00
Sum	1993.00	2239.00	1935.00	2504.00

Table 2 presents the average pre-test score for the STAD model group is 56.94, while the post-test score is 63.97. In comparison, the average pre-test score for the NHT model group is 56.91, with a post-test score of 73.65. This indicates a gain in learning motivation for both groups.

Table 3 summarizes the normality test results for all variables.

Table 3. Normality Test Results for Cognitive Achievement and Learning Motivation in Colloidal Material for Both Groups

Group		p-value	Decision
STAD Model	Pre-test of Cognitive Achievement	0.113	Normal
	Post-test of Cognitive Achievement	0.100	Normal
	Pre-test of Learning Motivation	0.101	Normal
	Post-test of Learning Motivation	0.144	Normal
NHT Model	Pre-test of Cognitive Achievement	0.113	Normal
	Post-test of Cognitive Achievement	0.106	Normal
	Pre-test of Learning Motivation	0.100	Normal
	Post-test of Learning Motivation	0.631	Normal

Table 3 indicates that the pre-test and post-test data for cognitive achievement and learning motivation in the colloidal material for both groups have a p-values greater than 0.05, indicating that all variables are normally distributed.

Table 4 presents the homogeneity test results for variables of cognitive achievement and learning motivation.

Table 4. Homogeneity Test Results for Cognitive Achievement and Learning Motivation in Colloidal Material for Both Groups

Group		Sig.	Decision
STAD Model	Pre-test-Post-test of Cognitive Achievement	0.109	Homogeneous
	Pre-test-Post-test of Learning Motivation	0.184	Homogeneous
NHT Model	Pre-test-Post-test of Cognitive Achievement	0.909	Homogeneous
	Pre-test-Post-test of Learning Motivation	0.159	Homogeneous

Evidence of data homogeneity is presented in Table 4, which shows that the pre-test and post-test scores for cognitive achievement and learning motivation for both groups have p-values > 0.05. Since the criteria for normality and homogeneity are met, data analysis can proceed with parametric statistics.

The research hypothesis was tested using paired sample t-tests and independent samples t-tests. The paired sample t-tests were done to assess the differences between the pre- and post-test scores for each experimental group. Tables 5 and 6 show the t-test results for cognitive achievement and learning motivation for the STAD group, respectively. Meanwhile, Tables 7 and 8 present the t-test results for these variables for the NHT group.

Table 5. t-Test Results Between Pre-test and Post-test of Cognitive Achievement for the STAD Group

Data	Average	t count	t table	p-value	Decision
Pre-test	52.76	17.066	2.032	0.000	Significant
Post-test	60.95				

Table 6. t-Test Results Between Pre-test and Post-test of Learning Motivation for the STAD Group

Data	Average	t count	t table	p-value	Decision
Pre-test	56.94	8.931	2.032	0.000	Significant
Post-test	63.97				

The t-test results for the STAD group indicate significant improvements in both cognitive achievement and learning motivation. In Table 5, the pre-test average for cognitive achievement was 52.76, with a t count of 17.066, well above the t table value of 2.032. The p-value of 0.000 shows a substantial difference between the pre- and post-test scores, suggesting that the STAD model positively impacted students' cognitive achievement. Table 6 reveals a pre-test average of 56.94 for learning motivation, with a t count of 8.931, also higher than the t table value. The p-value of 0.000 confirms a significant difference in learning motivation scores. In summary, these results suggest that the STAD model effectively enhances students' cognitive achievement and learning motivation.

Similarly, the t-test results for the NHT model experimental group indicate significant enhancements in both cognitive achievement and learning motivation. In Table 7, the pre-test average for cognitive achievement was 52.74, with a t count of 10.921, which exceeds the t table value of 2.035. The p-value of 0.000 demonstrates a notable difference between the pre- and post-test scores, suggesting that the NHT model positively influenced students' cognitive achievement. Table 8 shows a pre-test average of 56.91 for learning motivation, accompanied by a t count of 12.577, also higher than the t table value. The p-value of 0.000 confirms a significant difference in learning motivation scores. In conclusion, the results suggest that the NHT model effectively improves both cognitive achievement and learning motivation among students.

Table 7. t-Test Results Between Pre-test and Post-test of Cognitive Achievement for the NHT Group

Data	Average	t count	t table	p-value	Decision
Pre-test	52.74	10.921	2.035	0.000	Significant
Post-test	75.10				

Table 8. t-Test Results Between Pre-test and Post-test of Learning Motivation for the NHT Group

Data	Average	t count	t table	p-value	Decision
Pre-test	56.91	12.577	2.035	0.000	Significant
Post-test	73.65				

Furthermore, independent samples t-tests were conducted on cognitive achievement and learning motivation variables between the two groups. Table 9 shows the results of these tests for cognitive achievement, while Table 10 presents the results for learning motivation.

Table 9. Independent Samples t-Test Results for Cognitive Achievement for the STAD and NHT Model Experimental Groups

Group	Average	t count	t table	p-value	Decision
STAD Model	7.60	6.902	1.996	0.000	Significant
NHT Model	21.97				

Note: The data used were the post-test scores on cognitive achievement.

Table 10. Independent Samples t-Test Results for Learning Motivation for the STAD and NHT Model Experimental Groups

Group	Average	t count	t table	p-value	Decision
STAD Model	7.03	6.332	1.996	0.019	Significant
NHT Model	16.74				

Note: The data used were the post-test scores on learning motivation.

The independent samples t-test results for cognitive achievement and learning motivation between the STAD and NHT model experimental groups indicate significant differences, leading to the acceptance of the hypotheses (Ha). In Table 9, the average post-test score for the STAD model group was 7.60, with a t count of 6.902, compared to a t table value of 1.996 and a p-value of 0.000. This significant p-value suggests that the cognitive achievement scores of students in the STAD model group differ significantly from those in the NHT model group, demonstrating that the teaching method employed in the NHT model was more effective in enhancing cognitive achievement.

Similarly, Table 10 presents the results for learning motivation, where the STAD model group had an average post-test score of 7.03, with a t count of 6.332, a t table value of 1.996, and a p-value of 0.019. The significant p-value indicates a notable difference in learning motivation between the two groups, suggesting that the NHT model was more effective in fostering learning motivation among students compared to the STAD model. In conclusion, these results confirm the acceptance of the hypotheses (Ha), showing that students in the NHT model group outclassed those in the STAD model group in both cognitive achievement and learning motivation.

The increase in cognitive performance and learning motivation related to colloidal material is determined by calculating the normalized gain score (N-Gain). This calculation uses the student's pre- and post-test. The analysis was done manually using *Excel*, and the results are presented in Table 11 for cognitive achievement and Table 12 for learning motivation.

Table 11. N-Gain in Cognitive Achievement

Model	Average Score		Increase	N-Gain	Category
	Pre-test	Post-test			
STAD	52.76	60.95	8.19	0.17	Low
NHT	52.74	75.10	22.36	0.47	Medium

Table 12. N-Gain in Learning Motivation

Model	Average Score		Increase	N-Gain	Category
	Pre-test	Post-test			
STAD	56.94	63.97	7.03	0.16	Low
NHT	56.91	73.65	16.74	0.39	Medium

The N-Gain scores in cognitive achievement, as shown in Table 11, indicate that the STAD model group achieved a low increase in cognitive performance with an N-Gain of 0.17, while the NHT model group demonstrated a medium increase with an N-Gain of 0.47. In terms of learning motivation, presented in Table 12, the STAD model group also achieved a low increase in motivation with an N-Gain of 0.16, whereas the NHT model group achieved a medium increase with an N-Gain of 0.39. In summary, the NHT model group outperformed the STAD model group in both cognitive achievement and learning motivation.

Discussion

Various information obtained from this research is described in the study results. The objective of this study is to determine how the implementation of the STAD and NHT models can enhance cognitive achievement and students' motivation to learn colloidal material. The t-tests on the pre- and post-test for cognitive achievement and learning motivation indicate that the STAD model is effective in enhancing students' abilities. Students are more engaged in the instructional process, more enthusiastic about sharing what they learn, and more confident when presenting their work in front of the class. To supplement the lesson material, group members utilized activity sheets or other learning resources. They also support each other in understanding the material through quizzes, discussions, and tutorials.

The findings are in line with a study by Wahyuni (2019), which shows that students' comprehension of mathematical concepts taught using the STAD model is better than that of students taught using conventional methods. The study by Syakur and Sabat (2020) concludes, based on t-test results, that the cognitive achievements of students using the STAD model are better than those in the control class. Additionally, research by Kodang et al. (2022) demonstrates that the implementation of the STAD model can enhance student learning achievements on human respiratory system material. Moreover, the STAD model has been shown to enhance mathematical communication skills and mathematics learning achievements (Murtiyasa & Hapsari, 2020).

The analysis shows that the NHT model is efficient in enhancing cognitive achievement and learning motivation on colloidal materials. This is demonstrated by the t-test results on the pre- and post-test for cognitive achievement and learning motivation. The findings of this study are supported by Leasa and Corebima (2017), who reported that the NHT model has a 72.45% likelihood of improving students' cognitive achievement compared to conventional learning models. Additionally, a study by Hidanurhayati et al. (2018) demonstrates that the NHT model can increase students' learning motivation. Widyastuti (2021) also found that the NHT model helps students solve mathematical problems more effectively.

Silalahi et al. (2023) highlight that learners using the NHT model show better achievement motivation than those following conventional methods, reinforcing the effectiveness of NHT in enhancing student engagement. Additionally, a meta-analysis by Muzayyin et al. (2024) found a substantial effect size, indicating that the NHT model significantly boosts learning motivation, corroborating findings from multiple studies. The structure of the NHT model inherently promotes interaction and accountability among students. Jampel et al. (2018) noted that the NHT approach encourages students to take responsibility for their learning, actively participate in discussions, and share knowledge within their groups. This collaborative aspect not only enhances individual motivation but also cultivates a supportive learning community where students feel valued and engaged. Mustami and Safitri further support this by asserting that collaborative learning strategies like NHT are effective in increasing students' engagement and enthusiasm for learning (Mustami & Safitri, 2018).

The analysis indicates that cognitive achievement and learning motivation for colloidal material at MA Negeri 1 Banyumas differ significantly between the STAD and NHT learning models. The higher N-Gain value indicates that the NHT model is more efficient than the STAD model. In the NHT model experimental class, students are required to fully understand the material, leading to higher cognitive achievement and learning motivation compared to the STAD model class. This is because, in NHT type cooperative learning approach, the teacher selects one group member at random to present their group's findings, ensuring that all students are equally engaged. These results are in line with research from Fatoyah et al. (2020), which shows that students achieve better learning achievements in classes using the NHT model.

The finding that NHT performed better than STAD in both student cognitive achievement and motivation can be explained by the unique structure of NHT, which fosters greater student engagement and individual accountability. NHT emphasizes active participation from all group members by requiring each student to prepare for answering questions, promoting deeper understanding of the material. This approach ensures that every student contributes to the learning process, reducing the likelihood of passive participation, which can occur in STAD where more advanced students might dominate group activities.

The active learning aspect of NHT aligns with constructivist learning theory, particularly the ideas of social constructivism as proposed by Vygotsky (Amineh & Asl, 2015). This theory suggests that learning occurs through social interactions in which students construct knowledge through interaction and collaboration with their peers. The cooperative nature of NHT encourages students to engage in meaningful dialogue, helping them to scaffold their understanding through group discussions. This interactive approach to problem-solving helps students internalize knowledge more effectively than in STAD, where there may be less emphasis on such group-wide accountability.

Additionally, self-determination theory (SDT) by Deci and Ryan supports the higher levels of motivation observed with NHT (Ryan & Deci, 2000). SDT posits that intrinsic motivation is fostered when students experience autonomy, competence, and relatedness. NHT promotes autonomy by giving students a clear role in the group and responsibility for their answers. It also builds a sense of competence as students collaborate to ensure everyone understands the material before answering questions. This enhances students' confidence in their abilities, increasing their intrinsic motivation to engage with the content and take ownership of their learning process. In contrast, STAD may not offer the same level of individual accountability and interaction, leading to less pronounced gains in both cognitive achievement and motivation.

4. CONCLUSION

The study proposes the following conclusions: (a) The STAD model has a significant impact on cognitive achievement and learning motivation for colloidal material, as evidenced by a p-value of 0.000, which is less than 0.05; (b) Cognitive achievement and learning motivation for colloidal material are also significantly influenced by the NHT learning model, with a p-value of 0.000 (< 0.05); and (c) There are significant differences between the STAD and NHT models in terms of cognitive achievement and learning motivation for colloidal material. The NHT model shows higher N-Gain values of 0.47 and 0.39, compared to the STAD model with N-Gain values of 0.17 and 0.16

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