

The Effect of the Numbered Head Together Cooperative Learning Model Assisted by the Quizlet Application on Students' Mathematical Concept Understanding Ability

Adawiyah Ritonga^{*1}, Fibri Rakhmawati²,
^{1,2} Universitas Islam Negeri Sumatera Utara

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ABSTRACT

This study aimed to determine the effect of the Numbered Head Together (NHT) cooperative learning model assisted by the Quizlet application on students' mathematical conceptual understanding ability in the topic of relations and functions. The study employed a quantitative approach using an experimental method with a One Group Pretest-Posttest Design. The sample consisted of 30 students from class VIII-B. The research instrument was a mathematical conceptual understanding test administered before and after the treatment. Data were analyzed using the Shapiro-Wilk normality test, Levene homogeneity test, Paired Sample t-Test, Cohen's d effect size analysis, and N-Gain test. The results showed that the average pretest score of 54.47 increased to 80.00 in the posttest. The hypothesis test yielded a significance value of $0.000 < 0.05$, indicating a significant effect of the NHT learning model assisted by Quizlet on students' mathematical conceptual understanding ability. The effect size analysis produced a Cohen's d value of 5.03, which falls into the large category. Meanwhile, the N-Gain value was 0.563 or 56.33%, categorized as moderate, indicating that the learning process was sufficiently effective in improving students' mathematical conceptual understanding. Therefore, the NHT cooperative learning model assisted by the Quizlet application can be considered an effective alternative for enhancing students' mathematical conceptual understanding.

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Corresponding Author:

Adawiyah Ritonga
Departement of Mathematics Education,
Universitas Islam Negeri Sumatera Utara, Indonesia
Email: adawiyah0305222047@uinsu.ac.id

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1. INTRODUCTION

Mathematics is frequently viewed as an arduous and theoretical discipline. Nevertheless, at its core, mathematics constitutes a scholarly domain intricately connected to a multitude of quotidian endeavors (Maysarah et al., 2026). Mathematics can be conceptualized as a scientific discipline dedicated to the investigation of regularities, frameworks, and interconnections among abstract notions, which serve to elucidate diverse phenomena observed in our environment. As a theoretical science, mathematics transcends mere computation or numerical manipulation, encompassing instead the capacity for logical deduction, pattern analysis, and structured argumentation (Anggriany & Rakhmawati, 2024). These proficiencies are of considerable significance and find application across a broad spectrum of academic fields, including but not limited to physics, economics, and technology (Si et al., 2025).

The acquisition of mathematical knowledge constitutes a crucial domain within educational frameworks, exerting a profound influence on human existence, inasmuch as manifold quotidian endeavors are inextricably linked to the practical application of mathematical principles (Maysarah et al., 2023). The pedagogical engagement with mathematics represents a systematic endeavor designed to cultivate learners' comprehension of mathematical truths, theoretical constructs, foundational tenets, and proficiencies commensurate with their individual aptitudes (Lubis et al., 2025). Within this pedagogical paradigm, educators assume the role of facilitators, disseminating instructional content, while students actively engage in the construction and refinement of their own conceptual grasp of diverse mathematical ideas and frameworks. Moreover, the process of mathematical instruction also seeks to enhance the capacity for problem resolution, a skill indispensable across a spectrum of life circumstances (Muttaqin & Darmawan, 2022).

The field of mathematics education encompasses a multitude of concepts requiring student mastery, with the topic of relations and functions being one such area. As indicated by Ramadan & Arfinanti (2019) in their work referenced by (Arfany & Faradiba, 2022), the subject of relations and functions constitutes a foundational element of considerable significance within mathematical pedagogy. A robust comprehension of this concept is imperative, given its role as a prerequisite for grasping subsequent mathematical subjects, including but not limited to, linear equations and systems thereof. Consequently, a proficient grasp of relations and functions exerts a substantial influence on students' academic achievements in navigating more intricate mathematical concepts.

Subsequent to preliminary observations undertaken on December 15, 2025, within the pedagogical context, it was ascertained that a significant determinant of students' diminished comprehension levels was attributed to the prevailing direct instruction model. This model was predominantly characterized by didactic exposition and the assignment of discrete tasks. During its application, the educator occupied a central role in the educational trajectory, consequently leading to suboptimal student engagement in instructional and learning endeavors. This scenario engendered a disposition of passivity among learners, thereby curtailing their avenues for proactive involvement in the academic discourse (Talib et al., 2025).

This aligns with the findings of (Darwan et al., 2023), who posited that a deficiency in students' capacity to grasp mathematical principles can be attributed, in part, to pedagogical approaches that remain predominantly teacher-centric. Such an environment fosters a reliance on the instructor as the primary purveyor of knowledge, consequently diminishing avenues for self-directed inquiry and the active construction of mathematical comprehension. Therefore, the potential for students to cultivate and internalize mathematical concepts autonomously has not been fully realized or optimized.

Addressing the aforementioned challenges, the suboptimal comprehension of mathematical concept among students necessitates focused consideration and the deployment of effective interventions (Narpila, 2023). Consequently, the integration of novel pedagogical approaches in mathematics instruction, coupled with the judicious selection of instructional resources, is imperative to foster enhanced student engagement, autonomy, and active participation throughout the educational journey. This, in turn, is anticipated to facilitate the optimal development and enhancement of students' capacity for understanding mathematical concepts (Talib et al., 2025).

Among the pedagogical frameworks amenable to elevating students' proficiency in grasping mathematical concepts is the Numbered Heads Together (NHT) learning model. This instructional strategy affords students the prospective avenues for discourse and the exchange of perspectives with their respective group constituents, thereby enabling the expansion of their knowledge base and the profundity of their comprehension. Via collaborative group endeavors, students are also incentivized to apply acquired principles in the collective resolution of diverse problem sets (Pasaribu et al., 2024).

The pedagogical approach known as Numbered Heads Together (NHT) commences with the educator presenting a problem for students to resolve. Following this, students engage in collaborative deliberation within their respective groups to ascertain solutions to the posed problem (Batubara & Reflina, 2023). Upon conclusion of the group discussions, the instructor randomly selects a student's number to articulate the outcomes of the collective inquiry. This structured procedure is intended to foster the active participation of all learners and to distribute accountability for the group's endeavors equitably, thereby mitigating the tendency of individual students to monopolize instructional engagement (Fadly, 2022).

Beyond the adoption of suitable pedagogical frameworks, leveraging technology as a conduit for mathematical instruction presents a promising avenue for enhancing the efficacy of students' educational trajectories (Rafiela & Andhany, 2023). Educational media encompass any instrument or resource employed in conveying didactic content across diverse communication platforms, with the capacity to engage students' cognitive, affective, and psychomotor domains (Hasri et al., 2026). Consequently, educational media can foster a more robust learning environment, aid students in the assimilation of novel concepts, and contribute to the expedited attainment of learning objectives (Daniyati et al., 2023).

The implementation of digital learning resources can significantly bolster students' comprehension of mathematical principles. Furthermore, the synthesized effect size derived from meta-analyses of empirical research indicates a substantial positive impact, underscoring the potent influence of digital media on the improvement of mathematics learning achievements (Azkia et al., 2023).

Among the digital media available, the Quizlet application presents a valuable resource. Quizlet is characterized as a straightforward, novel, and user-friendly educational tool that actively facilitates student learning. This application is accessible for download via the Play Store or can be directly utilized through its official online portal at <https://quizlet.com/>. Annually, Quizlet garners engagement from over 20 million active participants, utilizing both its web-based platform and its dedicated mobile application. The inherent user-friendliness of Quizlet renders it appropriate for a broad spectrum of educational strata, extending from primary education to tertiary institutions (Panjaitan & Siregar, 2024). Furthermore, Quizlet is engineered and refined to underpin pedagogical endeavors across a diverse array of academic disciplines, transcending the confines of mere language acquisition. Educators can leverage this platform to curate instructional content, develop exercise modules, and implement learning assessments in a manner that is both more dynamic and efficacious (Sari, 2019).

Subsequent scholarly investigations by (Dadri et al., 2019) have demonstrated that the application of the Numbered Heads Together (NHT) cooperative learning paradigm can lead to enhancements in students' academic achievements and their capacities for critical analysis. This suggests that the NHT model fosters a more enriching pedagogical environment by promoting active student engagement, synergistic collaboration, and direct involvement in the educational process.

This perspective is further corroborated by the research of Akuba et al (2025), who reported that the integration of the Numbered Heads Together (NHT) learning model alongside interactive instructional resources has effectively bolstered students' cognitive proficiencies. Moreover, this synergistic approach is instrumental in cultivating social competencies, nurturing a sense of accountability, and augmenting students' self-reliance in the acquisition of mathematical knowledge (Faisal et al., 2023).

This observation is similarly corroborated by the findings of Tiwow et al (2022), whose investigation elucidated a significant impact of Powtoon animated learning media on students' mathematical academic achievements. Beyond the utilization of Powtoon, educators possess the capacity to leverage a diverse array of supplementary technology-driven pedagogical tools, including but not limited to Kahoot!, Quizizz, Wordwall, and Quizlet, to augment the instructional experience.

The theoretical lacuna addressed by this investigation stems from the observed discrepancies between established theoretical frameworks and the empirical evidence derived from prior scholarly endeavors. Concurrently, from a pedagogical standpoint, the Numbered Heads Together (NHT) cooperative learning methodology is posited to enhance student engagement and cognitive assimilation due to its inherent emphasis on collaborative discourse and the assignment of distinct individual accountability. Furthermore, the integration of digital instructional resources, exemplified by platforms such as Quizlet, is anticipated to facilitate a deeper comprehension of subject matter through the provision of interactive drills and prompt evaluative responses. Nevertheless, a review of the extant literature reveals that the efficacy of the NHT model and the Quizlet application has predominantly been evaluated in isolation. Investigations pertaining to NHT typically concentrate on its impact on students' academic achievements or levels of active participation. Conversely, research concerning Quizlet more frequently explores its capacity to foster enhanced learning motivation or its utility as a tool for reinforcing academic material through practice activities. Research integrating the Numbered Heads Together (NHT) pedagogical framework with the Quizlet digital platform within a systematic educational setting to ascertain their impact on students' comprehension of mathematical principles remains relatively scarce.

The distinctive contribution of the present inquiry resides in the synergistic amalgamation of the Numbered Heads Together (NHT) pedagogical framework and the Quizlet digital application, orchestrated within a structured educational design. Prior scholarly endeavors examining the NHT model and the deployment of Quizlet in mathematical instruction have predominantly pursued these components in isolation and have been comparatively scarce. This research, conversely, effectuates a convergence of these methodologies, thereby enabling the concurrent application of a collaborative learning paradigm and digital instrumentation to enhance students' proficiency in grasping mathematical concepts.

Consequently, there is a compelling need to investigate the influence of the Numbered Heads Together (NHT) cooperative learning paradigm, augmented by the Quizlet application, on students' capacity to grasp mathematical concepts. It is anticipated that this investigation will foster advancements in pedagogical approaches to mathematics,

promoting more dynamic, engaging, and efficacious methods for enhancing students' mathematical conceptual understanding.

2. METHOD

This study employed a quantitative approach using a pre-experimental method with a One-Group Pretest–Posttest Design. This design was used to evaluate changes in students' mathematical conceptual understanding before and after the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application. According to (Creswell, 2009) the one-group pretest–posttest design enables researchers to compare the initial and final conditions of the same participants after receiving a treatment, thereby allowing the identification of the effect of an instructional intervention. The research design can be illustrated as follows:

Table 1. Research Design

O ₁	X	O ₂
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Where:

- O₁ = Pretest of students' mathematical conceptual understanding
- X = Instruction using the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application
- O₂ = Posttest of students' mathematical conceptual understanding.

The population of this study consisted of all eighth-grade students at MTs Zia Salsabila in the 2025/2026 academic year, totaling 62 students, comprising 32 students in Class VIII-A and 30 students in Class VIII-B. The research sample consisted of 30 students from Class VIII-B, selected using the cluster random sampling technique based on class characteristics that were considered appropriate for the objectives of the study.

The research instrument was a mathematical conceptual understanding test on the topic of Relations and Functions, administered both before the treatment (pretest) and after the treatment (posttest). The test was developed based on the indicators of mathematical conceptual understanding aligned with the learning objectives of the topic. The indicators of mathematical conceptual understanding included:

1. Restating a mathematical concept.
2. Providing examples and non-examples of a concept.
3. Classifying objects according to their defining characteristics.
4. Applying concepts or algorithms to solve mathematical problems.

The research instrument consisted of an essay test comprising five items for the pretest and five items for the posttest. Prior to its administration, the instrument was validated by expert validators to assess its content validity, construct validity, and language appropriateness. The reliability of the instrument was evaluated using Cronbach's Alpha coefficient, yielding a value of 0.907, which indicates that the instrument was highly reliable and suitable for use in this study.

Data collection was conducted in three stages. The first stage involved administering a pretest to determine students' initial level of mathematical conceptual understanding. The second stage consisted of implementing the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application on the topic of Relations and Functions over two instructional sessions. The final stage involved administering a posttest using an instrument equivalent to the pretest to measure changes in students' mathematical conceptual understanding after the learning intervention.

The data were analyzed using both descriptive and inferential statistics. Descriptive statistics were used to summarize the characteristics of the data through the mean, minimum score, and maximum score. Prior to hypothesis testing, the difference score between each student's posttest and pretest scores was calculated.

The normality of the distribution of the difference scores was then examined using the Shapiro–Wilk test, as one of the primary assumptions of the paired-samples t-test is that the distribution of the difference scores is approximately normal (Pallant, 2010). If the significance value exceeded 0.05, the data were considered to satisfy the normality assumption, and the analysis proceeded with the paired-samples t-test.

The research hypothesis was tested using a paired-samples t-test to determine whether there was a statistically significant difference between the pretest and posttest scores of the same group at a significance level of 5% ($\alpha = 0.05$). The null hypothesis (H_0) was rejected when the sig.(2-tailed) < 0.05 , indicating that the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application had a statistically significant effect on students' mathematical conceptual understanding (Field, 2018).

In addition to hypothesis testing, the magnitude of the treatment effect was measured using Cohen's d for paired samples to determine the strength of the instructional intervention on students' mathematical conceptual understanding (Lakens, 2013). Cohen's d was calculated using the following formula:

$$d = \frac{t}{\sqrt{n}}$$

Where:

- d = effect size
- t = Calculated t-value
- n = Sample size

According to (Cohen, 1988), the criteria for interpreting effect size values are as follows:

Table 2 Effect Size Criteria

No	Cohens'd	Classification
1	$\geq 0,80$	High
2	0,50	Medium
3	0,20	Low

Furthermore, the improvement in students' learning outcomes was analyzed using the Normalized Gain (N-Gain) to determine the effectiveness of the learning intervention based on the normalized increase between the pretest and posttest scores (Hake, 1999). The N-Gain was calculated using the following formula:

$$(g) = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}}$$

Finally, all statistical analyses were performed using IBM SPSS Statistics version 25.

3. RESULTS AND DISCUSSION

3.1 Result

Descriptive Statistics Results

Based on the results of the descriptive statistical analysis, the mean score for the initial observation (pretest) was 54.620, with a minimum score of 42, a maximum score of 68, and a standard deviation of 7.542. After the treatment was administered, the mean score for the final observation (posttest) increased to 80.4138, with a minimum score of 66, a maximum score of 88, and a standard deviation of 5.840, as presented in Table 3.

Table 3. Descriptive Statistics Results

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	30	42	68	54.620	7.542
Post-test	30	66	88	80.413	5.840

The increase in the mean score from the pretest to the posttest indicates an improvement in students' mathematical conceptual understanding after the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application. Furthermore, the decrease in the standard deviation in the posttest indicates that the variation in students' scores became smaller, suggesting that students' mathematical conceptual understanding was more evenly distributed after the treatment than before it was administered.

Normality Test Results

Before conducting the hypothesis test, the difference score between each student's posttest and pretest scores was first calculated. Subsequently, the normality of the distribution of the difference scores was assessed using the Shapiro–Wilk test, as one of the assumptions underlying the use of the paired-samples t-test.

Table 4. Normality Test Results
Shapiro-Wilk

	Statistic	df	Sig
Difference Score	0.972	30	0.595

Based on table 4, the Shapiro-Wilk test yielded a significance value of $0.595 > 0.05$. Therefore, the difference scores ($d = \text{posttest} - \text{pretest}$) were considered to be normally distributed. Therefore, the data satisfied the assumption required for analysis using the paired-samples t-test.

Hypothesis Test Results

A paired-samples t-test was conducted to determine whether there was a significant difference in students' mathematical conceptual understanding before and after the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application. The results of the analysis are presented in table 5.

Table 5. Paired Sample Test Result

Mean	Std. deviation	Std. Error Mean	95% confidence interval of the difference		t	df	Sig.(2 -tailed
			lower	upper			
-25.800	5.129	0.936	-27.71	23.885	-27.553	29	0.000

Based on table 5, the Paired-Sample t-Test produced a calculated t-value of 27.71 with 29 degrees of freedom (df) and a significance level (Sig. 2-tailed) of 0.000, which is less than 0.05. Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. These findings indicate that there was a statistically significant difference between the pretest and posttest scores. Therefore, the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application had a significant effect on students' mathematical conceptual understanding of the topic of Relations and Functions.

Effect Size Results

The magnitude of the treatment effect was further examined using Cohen's d . The results are presented in table 6.

Table 6. Effect Size Results

Statistic	value
Cohen's d	5.03
Category	Large

The analysis yielded a Cohen's d value of 5.03, which is classified as a large effect. This finding indicates that the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application had a very large effect on improving students' mathematical conceptual understanding.

N-Gain Result

In addition to examining the statistical significance and the magnitude of the treatment effect, this study also analyzed students' learning improvement using the Normalized Gain (N-Gain). The results of the analysis are presented in table 7.

Table 7. N-Gain Result

Statistic	value
N-Gain	0.563
N-Gain percentage	56.33
Category	medium

Based on the analysis, the N-Gain value was 0.563 (56.33%), which falls into the moderate category. These results indicate that the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application produced a moderate improvement in students' mathematical conceptual understanding. Overall, these findings suggest that the implemented learning model effectively enhanced students' mathematical conceptual understanding following the instructional intervention.

Further evidence of the effect of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application on students' mathematical conceptual understanding can also be observed through an analysis of students' written responses based on the indicators of mathematical conceptual understanding.

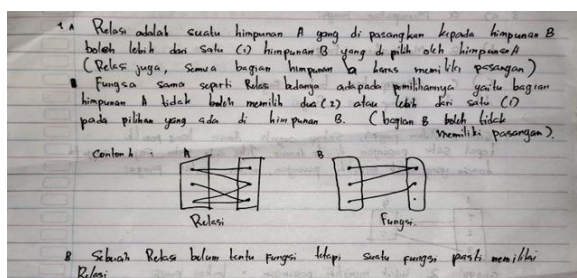


Figure 1. Restating a mathematical concept

Based on the analysis of the students' written responses, it can be concluded that the students' answers met the indicator of restating a concept, although some responses still contained minor inaccuracies and required improvement. This can be observed from the students' ability to explain the concepts of relations and functions in their own words. In their responses, the students stated that a relation is a connection between Set A and Set B in which an element may be associated with more than one element, whereas a function was described as a special type of relation in which each element of Set A is paired with only one corresponding element in Set B. These responses indicate that the students understood the fundamental concepts of relations and functions and were able to restate the concepts using their own words. Therefore, the indicator of restating a concept was successfully achieved.

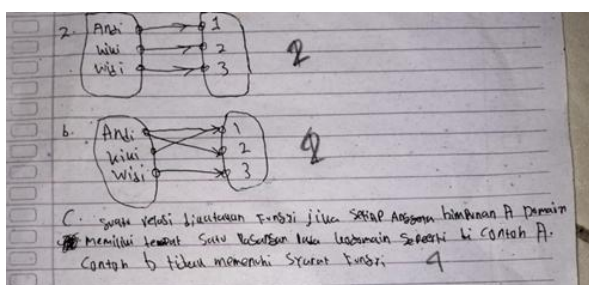


Figure 2. Providing examples and non-examples of a concept

Based on the analysis of the students' written responses, it can be concluded that the students' answers fulfilled the indicator of providing examples and non-examples. This is evident from the students' ability to present examples of relations that are functions and relations that are not functions using arrow diagrams accompanied by written explanations. Therefore, the students' responses satisfied the indicator of providing examples and non-examples, as they were able to identify examples of functions, distinguish them from non-functions, and explain the differences between the two based on the correct concept of a function.

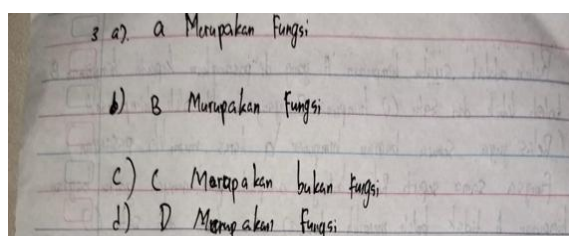
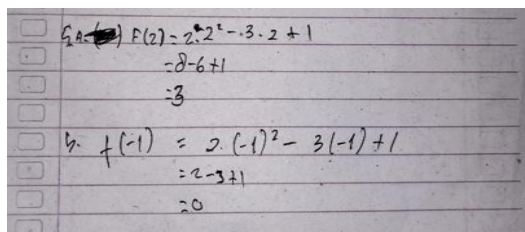


Figure 3. Classifying objects according to their defining characteristic

Based on the analysis of the students' written responses, it can be concluded that the students' answers fulfilled the indicator of classifying objects according to the concept. This

is demonstrated by the students' ability to identify and classify objects as either functions or non-functions based on the concepts they had learned. Furthermore, the students' responses indicate that they understood the defining characteristics of a function, enabling them to classify the objects accurately.



$$f(x) = 2x^2 - 3x + 1$$

$$f(2) = 2(2)^2 - 3(2) + 1$$

$$= 8 - 6 + 1$$

$$= 3$$

$$f(-1) = 2(-1)^2 - 3(-1) + 1$$

$$= 2 + 3 + 1$$

$$= 6$$

Figure 4. Applying concepts or algorithms to solve mathematical problems

Based on the analysis of the students' written responses, it can be concluded that the students' answers fulfilled the indicator of Applying concepts or algorithms to solve mathematical problems. This is evident from the students' ability to correctly determine the value of a function by substituting the given variable values into the corresponding algebraic function expression. These responses demonstrate that the students were able to apply the mathematical concepts they had learned to solve problems accurately.

Based on the analysis of the students' written responses across all indicators, it can be concluded that the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application had a positive effect on students' mathematical conceptual understanding. This effect is reflected in the students' ability to understand, classify, represent, and apply the concepts of relations and functions in accordance with the indicators of mathematical conceptual understanding.

3.2 Discussion

The findings of this study indicate that the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application had a significant effect on students' mathematical conceptual understanding of the topic of Relations and Functions. This finding is evidenced by the increase in students' mean scores following the intervention, which was further supported by the results of the paired-samples t-test, revealing a statistically significant difference between the pretest and posttest scores. Furthermore, the effect size analysis indicated a large effect, whereas the Normalized Gain (N-Gain) analysis showed that the improvement in students' mathematical conceptual understanding was in the moderate category. These findings suggest that integrating a cooperative learning model with a digital learning application can substantially enhance the quality of mathematics instruction.

The improvement in students' mathematical conceptual understanding can be explained by the characteristics of the Numbered Heads Together (NHT) learning model, which places students at the center of the learning process. During the numbering stage, each group member is assigned equal responsibility for completing the learning tasks. Subsequently, in the heads together stage, students discuss alternative solutions, exchange ideas, clarify their understanding, and collaboratively construct mathematical concepts. When the teacher calls a specific number during the answering stage, every student is expected to understand the outcomes of the group discussion because each member has an equal opportunity to represent the group. This mechanism encourages the active participation of all students throughout the learning process while simultaneously promoting individual accountability for the group's success. These findings are consistent with the

principles of cooperative learning, which emphasize social interaction, positive interdependence, individual accountability, and active participation as key factors contributing to improved learning outcomes (Johnson & Jhonson, 2009).

In addition to the cooperative learning model, the use of the Quizlet application also contributed to the improvement of students' mathematical conceptual understanding. Quizlet serves not only as a platform for presenting instructional content but also provides various learning features, including flashcards, Learn, educational games, and interactive quizzes that enable students to review concepts independently. Repeated practice accompanied by immediate feedback helps students strengthen their conceptual representations and reduce misconceptions. From the perspective of cognitive psychology, this learning process is consistent with the principle of retrieval practice, which refers to the repeated recall of information and has been shown to be more effective in strengthening long-term retention than simply rereading learning materials (Roediger & Karpicke, 2006). Therefore, the integration of the NHT learning model and the Quizlet application not only increases students' engagement during collaborative discussions but also reinforces concept internalization through adaptive and repetitive practice.

The findings of this study also support Vygotsky's social constructivist theory, which posits that knowledge is constructed through social interaction and collaboration among learners. Throughout the group discussion process, students were provided with opportunities to express their ideas, explain mathematical concepts, and evaluate the understanding of their peers. Such interactions facilitated the negotiation of meaning, enabling mathematical concepts to be understood through collaborative reasoning rather than memorized mechanically. Consequently, cooperative learning not only improves students' learning outcomes but also promotes the development of mathematical communication skills, critical thinking, and responsibility for learning (Slavin, 2005).

The findings of this study are consistent with those reported by (Dadri et al., 2019), who found that the Numbered Heads Together (NHT) cooperative learning model effectively improves students' learning outcomes and critical thinking skills. Similarly, (Akuba et al., 2025) reported that the implementation of the NHT model supported by interactive learning media had a positive effect on students' mathematical problem-solving abilities while also enhancing their responsibility and active participation in learning. Likewise, (Faisal et al., 2023) concluded that cooperative learning promotes students' sense of responsibility, independence, and active engagement throughout the mathematics learning process. The consistency of these findings suggests that the core characteristics of the NHT model namely, structured group discussions and individual accountability consistently create a more active and meaningful learning environment.

From the perspective of digital learning media, the findings of this study also support those of (Rodliyah, 2021), who reported that integrating cooperative learning models with digital platforms creates a more interactive and engaging learning environment while increasing students' participation. Although that study employed Baamboozle as the learning platform, whereas the present study used Quizlet, both studies demonstrate a similar pattern: the use of digital learning media strengthens the implementation of cooperative learning by providing more engaging learning activities and enabling students to receive immediate feedback throughout the learning process. These findings suggest that successful learning is influenced not only by the instructional model employed but also by the selection of digital learning media that effectively facilitate interaction, practice, and continuous reinforcement of conceptual understanding.

Nevertheless, the N-Gain analysis indicated that the improvement in students' mathematical conceptual understanding remained within the moderate category. This finding suggests that although the NHT model assisted by the Quizlet application

significantly improved students' conceptual understanding, other factors also influenced the extent of the learning gains. Differences in students' prior knowledge, limited instructional time, students' adaptation to a new instructional approach, and the complexity of the topic of Relations and Functions may have contributed to the improvement not reaching the high category. Therefore, implementing this instructional model over a longer period and incorporating a wider variety of learning activities may lead to greater improvements in students' mathematical conceptual understanding.

The implications of this study suggest that integrating a cooperative learning model with digital learning media can serve as an effective alternative strategy for mathematics instruction, particularly in improving students' mathematical conceptual understanding. For teachers, the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application can be used to create a more active, collaborative, and student-centered learning environment. Furthermore, the use of Quizlet enables students to engage in independent practice outside classroom hours, allowing the reinforcement of mathematical concepts to continue beyond formal instruction. Consequently, the combination of cooperative learning and digital technology has the potential to promote more effective, interactive, and concept-oriented mathematics instruction.

4. CONCLUSION

This study demonstrates that the implementation of the Numbered Heads Together (NHT) cooperative learning model assisted by the Quizlet application has a positive effect on students' mathematical conceptual understanding of the topic of Relations and Functions. Learning that integrates structured group discussions with the use of digital learning media enhances students' engagement in the learning process while helping them develop and strengthen their mathematical conceptual understanding. These findings suggest that combining a cooperative learning model with digital learning media can serve as an effective instructional strategy for improving the quality of mathematics education.

From a theoretical perspective, this study reinforces previous findings regarding the effectiveness of the Numbered Heads Together (NHT) learning model and extends the empirical evidence that integrating cooperative learning with the Quizlet application can enhance students' mathematical conceptual understanding. From a practical perspective, the findings may serve as a reference for mathematics teachers in designing more active, collaborative, and student-centered learning experiences through the integration of digital technology.

Future research is recommended to employ experimental designs that include a control group, involve larger sample sizes, and examine the implementation of this instructional model across different mathematics topics and educational levels in order to provide a more comprehensive understanding of its effectiveness.

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