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The Effectiveness of the Deep Learning Curriculum-Based Numbered Heads Together (NHT) Model in Improving Quadratic Function Problem-Solving Skills among Madrasah Aliyah Students

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Abstract

Mathematical problem-solving is a fundamental competency in mathematics education; however, students continue to experience difficulties in solving problems involving quadratic functions. This condition underscores the need for an instructional approach that strengthens conceptual understanding while promoting active and meaningful student engagement. This study examined the effectiveness of a Deep Learning Curriculum (DLC)-based Numbered Heads Together (NHT) model in improving the mathematical problem-solving skills of Madrasah Aliyah students. A quantitative quasi-experimental approach with a nonequivalent control group design was employed, involving 32 students selected through purposive sampling. Data were collected using a mathematical problem-solving test and analyzed using an independent-samples *t* test, normalized gain (N-Gain), and Cohen's *d* effect size. The findings indicate that students in the experimental group demonstrated significantly higher problem-solving performance, greater learning gains, and a stronger instructional effect than those in the control group. These results confirm that the DLC-based NHT model is effective in enhancing students' mathematical problem-solving skills in quadratic function learning. The study contributes empirical evidence supporting the integration of meaningful and collaborative learning principles within cooperative mathematics instruction. Practically, the findings provide an alternative student-centered instructional strategy for supporting the implementation of the Merdeka Curriculum and improving students' mathematical problem-solving competencies.

Keywords: Collaborative Learning; Deep Learning Curriculum; Mathematical Problem-Solving; Numbered Heads Together; Quadratic Functions

INTRODUCTION

Mathematical problem-solving skills have become one of the core competencies expected in contemporary mathematics education because they enable students to analyze situations, formulate logical strategies, and apply mathematical concepts to solve authentic problems rather than merely performing routine calculations (Rambe & Afri, 2020). The implementation of the Merdeka Curriculum further reinforces this expectation by emphasizing meaningful learning experiences that encourage students to think critically, collaborate effectively, and construct knowledge independently through active participation in the learning process (Nugraha, 2022). Consequently, mathematics instruction is no longer oriented solely toward procedural mastery but also toward developing students' higher-order thinking skills as an essential foundation for lifelong learning (Susanto et al., 2021).

Despite these expectations, numerous studies have reported that students' mathematical problem-solving skills remain unsatisfactory across various educational levels. Many learners continue to experience difficulties when solving non-routine mathematical problems because they rely heavily on memorized formulas without adequately understanding the underlying mathematical concepts (Hidayat et al., 2022). Such conditions indicate that students frequently encounter obstacles in interpreting problems, selecting appropriate solution strategies, and evaluating the correctness of their answers systematically (Pratiwi & Hidayati, 2022). As a result, mathematics learning often produces procedural competence without sufficiently developing conceptual reasoning and independent problem-solving abilities (Rahmat et al., 2022).

These challenges are particularly evident in the topic of quadratic functions, which requires students to integrate algebraic reasoning, graphical interpretation, and contextual analysis simultaneously. Understanding quadratic functions involves more than applying formulas; students are expected to analyze relationships among mathematical representations and use these relationships to solve contextual problems accurately. However, previous studies have shown that misconceptions regarding the properties of quadratic functions, including determining the vertex, identifying the axis of symmetry, and interpreting graphical characteristics, continue to hinder students' mathematical reasoning (Khoiriyah, 2018). Consequently, students frequently demonstrate incomplete reasoning processes and experience difficulties in transferring conceptual knowledge to unfamiliar problem situations (Rahmat et al., 2022).

A similar phenomenon was identified during the preliminary investigation conducted at MAN 1 Jombang. Classroom observations and discussions with mathematics teachers indicated that many students encountered difficulties in solving contextual quadratic function problems because classroom instruction remained predominantly teacher-centered. Students tended to imitate solution procedures demonstrated by the teacher instead of constructing mathematical understanding independently through reasoning and discussion. This learning condition limited students' opportunities to explore multiple solution strategies and develop reflective thinking, ultimately affecting their mathematical problem-solving performance. Such findings suggest that instructional innovation is required to facilitate more meaningful learning experiences capable of improving students' conceptual understanding and mathematical reasoning (Hidayat et al., 2022).

One instructional approach that has consistently demonstrated positive outcomes in mathematics education is the Numbered Heads Together (NHT) cooperative learning model. Unlike conventional instruction, NHT encourages every student to participate actively by assigning individual responsibility within collaborative group discussions. The learning process requires each group member to understand the discussion outcomes because any student may be selected to represent the group in presenting the final solution (Pendy & Mbagho, 2021). This cooperative structure not only promotes active participation but also strengthens communication, collaborative reasoning, and shared responsibility throughout the learning process (Riansyah et al., 2020).

The effectiveness of the NHT model has been reported in numerous empirical studies. Kistian (2018) demonstrated that NHT significantly improves mathematics learning outcomes by increasing students' classroom participation and collaborative engagement. Similar findings were reported by Loti and Ndakularak (2025), who concluded that structured cooperative interaction enables students to understand mathematical concepts more effectively than conventional instruction. More recently, Ahsan (2025) found that NHT contributes positively to students' mathematical problem-solving skills because collaborative discussion encourages learners to construct mathematical reasoning rather than memorize solution procedures. Likewise, Regina et al. (2025) emphasized that NHT creates a learning environment that supports active participation while improving students' confidence in solving mathematical problems through peer interaction. Supporting these findings, Samuel et al. (2025) reported that the implementation of the NHT model assisted by learner worksheets significantly enhanced students' mathematical problem-solving skills, indicating that structured cooperative activities combined with appropriate learning resources promote deeper conceptual understanding and more effective problem-solving performance.

Nevertheless, previous studies have predominantly focused on evaluating the effectiveness of NHT in terms of students' learning achievement, participation, or general problem-solving performance. Relatively limited attention has been devoted to examining how cooperative learning can be integrated with the pedagogical principles of the Deep Learning Curriculum (DLC) to facilitate meaningful conceptual understanding and higher-order thinking during mathematics learning. Consequently, further investigation is needed to determine whether combining the cooperative characteristics of NHT with the cognitive orientation of the Deep Learning Curriculum can produce greater improvements in students' mathematical problem-solving skills, particularly in learning quadratic functions (Dahroni et al., 2025).

Recent educational reforms have introduced the Deep Learning Curriculum (DLC) as an instructional framework that emphasizes meaningful learning through active knowledge construction, critical reflection, and authentic problem-solving experiences. Unlike conventional instruction, which often prioritizes content acquisition and procedural performance, the DLC encourages students to develop conceptual understanding by connecting prior knowledge with new learning experiences while actively participating in collaborative inquiry (Muvid, 2024). This perspective is consistent with the concept of deep learning proposed by Fullan and Langworthy (2014), who argue that meaningful education should equip students with the competencies required to solve complex problems through creativity, communication, collaboration, critical thinking, character, and global citizenship.

Within mathematics education, integrating the principles of the Deep Learning Curriculum into cooperative learning is expected to improve not only students' academic achievement but also the quality of their mathematical reasoning. Structured collaboration supported by meaningful cognitive engagement encourages learners to explain ideas, justify mathematical arguments, evaluate alternative strategies, and reflect on the validity of their solutions. Consequently, classroom interaction becomes a process of collaborative knowledge construction rather than merely completing learning tasks (Fullan et al., 2013). Recent evidence also indicates that instructional approaches emphasizing meaningful learning are more effective in fostering conceptual understanding than learning environments that focus primarily on procedural practice (Dewi & Wulandari, 2025).

Although studies investigating the Numbered Heads Together (NHT) model have consistently reported positive learning outcomes, several limitations remain evident in the existing literature. Most previous studies evaluated the effectiveness of NHT primarily in terms of students' academic achievement, classroom participation, or general learning outcomes, while relatively few explored its contribution to developing higher-order mathematical thinking through a structured pedagogical framework (Loti & Ndakularak, 2025). Likewise, research concerning the Deep Learning Curriculum has mainly discussed its philosophical foundations and educational policies without providing sufficient empirical evidence regarding its implementation in mathematics classrooms, particularly through cooperative learning strategies (Muvid, 2024). Furthermore, recent studies integrating NHT with other instructional approaches have demonstrated positive results, yet they have not specifically examined its integration with the principles of the Deep Learning Curriculum in improving students' quadratic function problem-solving skills (Saptono, 2024).

This gap provides the rationale for the present study. Existing evidence suggests that cooperative interaction alone may not sufficiently promote meaningful mathematical learning unless students are guided to construct conceptual understanding through critical dialogue, reflective thinking, and collaborative inquiry. Therefore, integrating the cooperative structure of NHT with the pedagogical principles of the Deep Learning Curriculum is expected to strengthen students' mathematical reasoning by transforming classroom discussion into a process of meaningful knowledge construction. Such integration has received limited empirical attention despite its potential to address persistent difficulties in mathematical problem solving (Dahroni et al., 2025).

The novelty of this study lies in the development and evaluation of a Deep Learning Curriculum-Based Numbered Heads Together (NHT) model specifically designed to improve students' mathematical problem-solving skills in quadratic function learning. Unlike previous studies that mainly emphasized collaborative participation or learning achievement, this study integrates the operational stages of NHT with the principles of deep dialogue, deep thinking, and deep sharing, enabling students to construct conceptual understanding while solving contextual mathematical problems. Consequently, this study extends previous research by demonstrating that the effectiveness of cooperative learning depends not only on collaborative interaction but also on the quality of students' cognitive engagement throughout the learning process (Islamiah et al., 2025).

The theoretical framework of this study is established through the integration of three complementary perspectives. The Numbered Heads Together (NHT) model provides a cooperative learning structure that promotes active participation, shared responsibility, and collaborative reasoning among students (Slavin, 2021). The Deep Learning Curriculum serves as the pedagogical foundation that emphasizes meaningful learning and the development of twenty-first-century competencies through authentic learning experiences (Fullan & Langworthy, 2014). Meanwhile, students' mathematical problem-solving skills are assessed based on Polya's four-stage problem-solving framework, consisting of understanding the problem, devising a plan, carrying out the plan, and looking back to evaluate the obtained solution (Polya, 2004). The integration of these theoretical perspectives establishes a comprehensive instructional framework capable of facilitating meaningful mathematical learning and improving students' conceptual understanding.

Based on these considerations, this study aims to examine the effectiveness of the Deep Learning Curriculum-Based Numbered Heads Together (NHT) model in improving the quadratic function problem-solving skills of Madrasah Aliyah students. Specifically, the study investigates whether the proposed instructional model produces significantly better mathematical problem-solving performance than conventional instruction, enhances students' learning improvement, and generates meaningful instructional effectiveness. The findings are expected to enrich the literature on mathematics education while providing empirical evidence supporting the implementation of innovative, student-centered learning models aligned with the objectives of the Merdeka Curriculum.

METHODS

This study employed a quantitative approach using a quasi-experimental research design to examine the effectiveness of the Deep Learning Curriculum-Based Numbered Heads Together (NHT) model in improving students' mathematical problem-solving skills on quadratic functions. A quasi-experimental approach was selected because the researcher was unable to randomly assign participants to experimental conditions due to the existing classroom structure. Therefore, intact classes were maintained while investigating the causal relationship between the instructional intervention and students' learning outcomes. The study adopted the Nonequivalent Control Group Design, which involved an experimental group receiving the instructional treatment and a control group receiving conventional instruction. Both groups completed a pre-test before the intervention and a post-test after the intervention to evaluate differences in learning achievement attributable to the treatment.

The independent variable of this study was the implementation of the Deep Learning Curriculum-Based Numbered Heads Together (NHT) model, whereas the dependent variable was students' mathematical problem-solving skills in quadratic function learning. The instructional treatment integrated the four operational stages of the NHT model—numbering, questioning, heads together, and answering—with the cognitive principles of the Deep Learning Curriculum (DLC), emphasizing critical thinking, collaboration, communication, creativity, character, and citizenship. Students' mathematical problem-solving skills were assessed based on Polya's four-stage problem-solving framework, consisting of understanding the problem, devising a plan, carrying out the plan, and looking back. These indicators were selected because they represent the sequential cognitive processes required to solve contextual quadratic function problems and directly correspond to the study's research objective of evaluating improvements in students' mathematical problem-solving performance.

The population comprised all 489 eleventh-grade students enrolled at MAN 1 Jombang during the 2026/2027 academic year. The research sample consisted of two intact classes selected through purposive sampling based on recommendations from the mathematics teacher and the equivalence of students' initial mathematical abilities. Class XI-I was assigned as the experimental group, while Class XI-J served as the control group. This sampling technique was considered appropriate because random assignment of individual students was not feasible within the school's established classroom organization, while maintaining comparable academic characteristics between both groups ensured the validity of the experimental comparison.

RESULTS

1. Normality Test

Tests of Normality

	Kelas Penelitian	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Nilai Pre-test	Kelas Eksperimen	.121	16	.200*	.960	16	.660
	Kelas Kontrol	.133	16	.200*	.963	16	.707
Nilai Post-test	Kelas Eksperimen	.150	16	.200*	.949	16	.468
	Kelas Kontrol	.118	16	.200*	.976	16	.927

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 1. Normality Test Results

Figure 1. Normality Test Results shows that all pre-test and post-test data for both the experimental and control groups had Shapiro–Wilk significance values greater than 0.05 (experimental pre-test = 0.660; control pre-test = 0.707; experimental post-test = 0.468; control post-test = 0.927). Therefore, all datasets were normally distributed and met the normality assumption required for subsequent parametric analysis.

2. Homogeneity Test

Test of Homogeneity of Variances

Pre-test Scores

Levene's Statistic	df1	df2	Sig.
.044	1	30	.836

Figure 2. Homogeneity Test Results for Pre-test Scores

Figure 2. Homogeneity Test Results for Pre-test Scores shows that the significance value obtained from Levene's Test for the pre-test scores was 0.836, which is greater than the significance level of 0.05. Therefore, the null hypothesis (H_0) was accepted, indicating

that the variances of the experimental and control groups for the pre-test data were homogeneous.

Test of Homogeneity of Variances

Post-test Scores

Levene's Statistic	df1	df2	Sig.
.002	1	30	.961

Figure 3. Homogeneity Test Results for Post-test Scores

Figure 3. Homogeneity Test Results for Post-test Scores shows that the significance value obtained from Levene's Test for the post-test scores was 0.961, which is also greater than the significance level of 0.05. Therefore, the null hypothesis (H_0) was accepted, indicating that the variances of the experimental and control groups for the post-test data were homogeneous.

3. Hypothesis Testing (Independent Samples *t*-Test)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nilai Post-test	Equal variances assumed	.002	.961	6.196	30	.000	14.313	2.310	9.595	19.030
	Equal variances not assumed			6.196	29.786	.000	14.313	2.310	9.594	19.031

Figure 5. Independent Samples t-Test Results

Figure 5. Independent Samples *t*-Test Results shows that the significance value (Sig. 2-tailed) was 0.000, which is lower than 0.05. Therefore, the null hypothesis (H_0) was rejected, indicating a significant difference in mathematical problem-solving ability between students taught using the Numbered Heads Together (NHT) model based on the Deep Learning Curriculum (DLC) and those who received conventional instruction. These findings demonstrate that the NHT model based on DLC had a significant effect on students' mathematical problem-solving ability.

4. Normalized Gain (N-Gain) Analysis

Table 1. N-Gain Analysis Results

Group	Mean Pre-test	Mean Post-test	Mean N-Gain	Category
Experimental	44.38	83.50	0.71	High
Control	45.63	69.19	0.43	Moderate

source: Compiled by the researcher (2026)

Table 1. N-Gain Analysis Results shows that the experimental group achieved an average N-Gain score of 0.71, which falls into the high category, while the control group obtained an average N-Gain score of 0.43, which is classified as moderate. These findings indicate that students in the experimental group experienced greater improvement in mathematical problem-solving ability than those in the control group.

5. Effect Size Analysis

Table 2. Effect Size Analysis Results

Variabel	Kelas	N	Rata-rata	Standar Deviasi	Nilai Cohen's d	Kategori
Post-test Scores	Experimental	16	83,50	6,250	2,19	Large
	Control	16	69,19	6,804		

source: Compiled by the researcher (2026)

Table 2. Effect Size Analysis Results shows that the calculated Cohen's *d* value was 2.19, indicating a large effect size. This result demonstrates that the implementation of the Numbered Heads Together (NHT) model based on the Deep Learning Curriculum (DLC) had a strong and substantial effect on improving students' mathematical problem-solving ability.

DISCUSSION

The present study aimed to evaluate the effectiveness of the Deep Learning Curriculum (DLC)-Based Numbered Heads Together (NHT) model in improving students' mathematical problem-solving skills on quadratic functions. The effectiveness of the proposed instructional model was examined through three complementary indicators: the difference in students' mathematical problem-solving performance between the experimental and control groups, the magnitude of students' learning improvement, and the overall instructional effect produced by the intervention. Collectively, the findings demonstrate that integrating the cooperative learning structure of NHT with the pedagogical principles of the

Deep Learning Curriculum provides a more effective learning environment than conventional mathematics instruction.

The first indicator concerns the difference in students' mathematical problem-solving performance following the instructional intervention. The experimental group achieved a considerably higher post-test mean score (83.50) than the control group (69.19), and the Independent Samples t-test confirmed that this difference was statistically significant. These findings indicate that students who learned through the DLC-based NHT model demonstrated superior mathematical problem-solving performance compared with those who experienced conventional instruction. The statistical evidence suggests that the observed improvement cannot be attributed solely to chance but reflects the positive contribution of the instructional model in facilitating students' conceptual understanding of quadratic functions.

The superiority of the experimental group can be explained by the learning characteristics embedded within the DLC-based NHT model. Throughout the instructional process, students were systematically guided through the four operational stages of NHT—numbering, questioning, heads together, and answering—while simultaneously engaging in deep dialogue, deep thinking, and deep sharing, which represent the core learning principles of the Deep Learning Curriculum. Rather than encouraging students to memorize mathematical formulas, these learning activities required them to identify mathematical information, formulate appropriate solution strategies, justify their reasoning during collaborative discussions, and evaluate the validity of their final answers. Such learning experiences are consistent with Polya's problem-solving framework, where students gradually develop conceptual understanding by progressing through the stages of understanding the problem, planning the solution, implementing the strategy, and reviewing the obtained results. Consequently, students were able to construct mathematical knowledge more meaningfully and apply it effectively to contextual quadratic function problems.

The second indicator of effectiveness is reflected in the Normalized Gain (N-Gain) analysis. The experimental group obtained a mean N-Gain score of 0.71, which falls within the high category, whereas the control group achieved a mean score of 0.43, categorized as moderate. These findings indicate that students exposed to the DLC-based NHT model experienced substantially greater learning improvement than those receiving conventional instruction. The high N-Gain score demonstrates that the intervention successfully promoted meaningful conceptual development rather than merely improving short-term academic performance. As students repeatedly practiced solving contextual quadratic function problems through collaborative inquiry and structured reflection, they gradually strengthened their reasoning processes and became more capable of transferring conceptual knowledge to unfamiliar mathematical situations.

The present findings are consistent with previous research highlighting the educational benefits of cooperative learning. Riansyah et al. (2020) reported that the NHT model enhances students' mathematical problem-solving skills by promoting collaborative reasoning and individual accountability during classroom discussion. Likewise, Pendy and Mbagho (2021) concluded that NHT is particularly effective for mathematical topics requiring strong conceptual understanding because every learner is encouraged to participate actively in constructing knowledge. However, the present study extends these findings by demonstrating that cooperative interaction alone is insufficient to maximize students' mathematical reasoning unless it is supported by the pedagogical principles of the Deep Learning Curriculum. Through the integration of meaningful learning experiences, structured collaboration, and higher-order cognitive engagement, the DLC-based NHT model enables students to move beyond procedural problem solving toward deeper conceptual understanding of quadratic functions.

The third indicator of instructional effectiveness was evaluated through Cohen's d effect size, which produced a value of 2.19, indicating a large effect. Unlike significance testing, which merely determines whether differences exist between groups, effect size estimates the practical magnitude of an intervention. The large effect identified in this study demonstrates that the superiority of the experimental group was not only statistically significant but also educationally meaningful. This finding suggests that integrating the cooperative structure of NHT with the cognitive orientation of the Deep Learning Curriculum substantially enhanced students' mathematical problem-solving performance in quadratic function learning. Consequently, the proposed instructional model can be regarded as an effective pedagogical approach capable of producing meaningful learning outcomes in mathematics classrooms.

The effectiveness of the proposed instructional model may be explained by the complementary roles performed by its two principal components. The Numbered Heads Together model provides a structured cooperative learning environment in which every student assumes individual responsibility for contributing to group learning through the mechanisms of numbering, collaborative discussion, and random response selection. Simultaneously, the Deep Learning Curriculum ensures that classroom interaction extends beyond procedural participation by encouraging students to engage in meaningful dialogue, critical reflection, and conceptual reasoning. The integration of these complementary approaches transformed collaborative discussion into an active process of knowledge construction, enabling students to understand the underlying mathematical concepts instead of merely applying memorized formulas. This pedagogical synergy appears to explain the substantial improvement observed in students' mathematical problem-solving performance throughout the intervention.

The present findings also extend previous studies concerning cooperative learning in mathematics education. Earlier investigations generally concluded that the NHT model improves students' learning achievement, participation, and collaborative interaction. However, many of these studies primarily emphasized procedural collaboration without explicitly integrating a pedagogical framework capable of promoting deeper conceptual understanding. The current study provides empirical evidence that the effectiveness of cooperative learning can be further strengthened when the social interaction facilitated by NHT is systematically guided through the principles of the Deep Learning Curriculum. In this context, collaborative discussion is no longer limited to exchanging answers but becomes a meaningful cognitive process through which students examine mathematical ideas, evaluate alternative strategies, and construct conceptual understanding collectively. Therefore, the present study contributes to the existing literature by extending the application of NHT beyond cooperative participation toward meaningful mathematical learning.

From a theoretical perspective, this study supports the argument that meaningful mathematical learning requires an instructional design integrating both collaborative interaction and cognitive engagement. While NHT establishes a cooperative classroom structure that promotes participation and individual accountability, the Deep Learning Curriculum provides the philosophical foundation necessary to facilitate higher-order thinking through meaningful learning experiences. The integration of these two approaches aligns with Polya's problem-solving framework by encouraging students to progress systematically through understanding the problem, planning an appropriate solution, implementing mathematical procedures, and evaluating the validity of their solutions. Consequently, the findings reinforce the proposition that conceptual understanding develops more effectively when cooperative learning is supported by instructional activities emphasizing critical thinking and reflective reasoning rather than procedural practice alone.

Practically, the findings provide an alternative instructional strategy for mathematics teachers implementing the Merdeka Curriculum, particularly in teaching quadratic functions. The structured integration of contextual learning tasks, collaborative discussion, and individual accountability creates learning experiences that actively involve students in constructing mathematical knowledge. Furthermore, the incorporation of the Deep Learning Curriculum enables teachers to foster not only conceptual understanding but also the development of twenty-first-century competencies through meaningful classroom interaction. Therefore, the DLC-based NHT model may serve as an effective instructional alternative for improving students' mathematical problem-solving skills while simultaneously supporting the student-centered learning orientation promoted by the national curriculum.

Despite these contributions, several limitations should be acknowledged. The study involved only 32 eleventh-grade students from a single Madrasah Aliyah, thereby limiting the generalizability of the findings to broader educational settings. In addition, the intervention focused exclusively on quadratic function learning and was implemented over two instructional meetings, which restricted the opportunity to evaluate the long-term sustainability of students' mathematical problem-solving development. Future research is therefore encouraged to examine the implementation of the DLC-based NHT model across different mathematical topics, educational levels, and longer intervention periods to provide more comprehensive evidence regarding its instructional effectiveness.

CONCLUSION

This study confirms that the Deep Learning Curriculum (DLC)-Based Numbered Heads Together (NHT) model is effective in improving students' mathematical problem-solving skills in quadratic function learning. The research objectives were successfully achieved through three indicators of instructional effectiveness: a significant difference in mathematical problem-solving performance between the experimental and control groups, greater learning improvement demonstrated by the experimental group, and a strong instructional effect resulting from the intervention. These findings indicate that integrating a cooperative learning structure with deep learning principles promotes not only higher academic achievement but also stronger conceptual understanding and mathematical reasoning when solving contextual problems.

From a theoretical perspective, this study contributes to mathematics education by providing empirical evidence that combining the cooperative structure of NHT with the pedagogical principles of the Deep Learning Curriculum enhances meaningful learning and higher-order thinking. From a practical perspective, the proposed instructional model offers mathematics teachers an alternative student-centered learning strategy that aligns with the objectives of the Merdeka Curriculum while fostering collaboration, critical thinking, and conceptual understanding. The novelty of this study lies in integrating the cognitive principles of the Deep Learning Curriculum into the operational stages of the NHT model, thereby transforming collaborative discussion into a process of meaningful knowledge construction rather than procedural task completion.

Future research is encouraged to examine the implementation of the DLC-based NHT model across different mathematical topics, educational levels, and broader participant groups to strengthen the generalizability of the findings. In addition, developing more diverse contextual learning materials may further enhance students' critical thinking and mathematical problem-solving skills through meaningful collaborative learning experiences.

REFERENCES

Ahsan, F. F. (2025). The effect of Numbered Heads Together (NHT) on elementary school students' mathematical problem-solving ability in geometry. *Mathline: Jurnal Matematika dan Pendidikan Matematika, 10*(3), 659–670. https://doi.org/10.31943/mathline.v10i3.787

Dahroni, Saputra, Z. A., Restiani, H., Ayu, M., & Pratiwi, R. H. (2025). Perbandingan Efektivitas Pembelajaran Deep Learning dan Diferensiasi terhadap Kemampuan Pemecahan Masalah dan Penalaran Matematika Siswa SMP. *Aljabar: Jurnal Ilmuan Pendidikan, Matematika dan Kebumian, 1*(3), 124–140. https://doi.org/10.62383/aljabar.v1i3.683

Fullan, M., & Langworthy, M. (2013). *Towards a new end: New pedagogies for deep learning*. Collaborative Impact. https://www.michaelfullan.ca/wp-content/uploads/2013/08/New-Pedagogies-for-Deep-Learning-An-Invitation-to-Partner-2013-6-201.pdf

Fullan, M., & Langworthy, M. (2014). *A rich seam: How new pedagogies find deep learning*. Pearson. https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/about-pearson/innovation/open-ideas/ARichSeamEnglish.pdf

Hidayat, R., Siregar, E. Y., & Elindra, R. (2022). Analisis Faktor-Faktor Rendahnya Kemampuan Pemecahan Masalah Matematis Siswa di SMK Swasta Teruna

Padangsidimpuan. *JURNAL MathEdu (Mathematic Education Journal), 5*(3), 114–120. https://doi.org/10.37081/mathedu.v5i3.3944

Islamiah, F., Majid, A. F., & Sulasteri, S. (2025). Pengaruh Penerapan Model Pembelajaran Kooperatif Tipe Numbered Head Together (NHT) terhadap Kemampuan Berpikir Kritis Peserta Didik dalam Pembelajaran Matematika. *Alauddin Journal of Mathematics Education, 7*(2), 112–126. https://doi.org/10.24252/ajme.v7i2.62199

Khoiriyah, S. (2018). Implementasi Model Pembelajaran Kooperatif Tipe NHT dalam Pembelajaran Matematika. *Jurnal e-DuMath, 4*(2), 30–35. https://doi.org/10.52657/je.v4i2.754

Kistian, A. (2018). Pengaruh Model Pembelajaran Numbered Head Together (NHT) terhadap Hasil Belajar Matematika Siswa di Kelas IV SDN 4 Banda Aceh. *Jurnal Genta Mulia, 9*(2), 71–82. https://ejournal.uncm.ac.id/index.php/gm/article/view/541

Loti, A. R. B., & Ndakularak, I. L. (2025). Efektivitas Model Pembelajaran Kooperatif Tipe Numbered Head Together (NHT) terhadap Hasil Belajar Siswa Kelas XI SMA PGRI Waingapu: Penelitian. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan, 4*(1), 3336–3341. https://doi.org/10.31004/jerkin.v4i1.1930

Muvid, M. B. (2024). Menelaah Wacana Kurikulum Deep Learning: Urgensi dan Peranannya dalam Menyiapkan Generasi Emas Indonesia. *Edu Aksara: Jurnal Pendidikan dan Kebudayaan, 3*(2), 80–93. https://doi.org/10.5281/zenodo.14403663

Nugraha, T. S. (2022). Kurikulum Merdeka untuk Pemulihan Krisis Pembelajaran. *Inovasi Kurikulum, 19*(2), 251–262. https://doi.org/10.17509/jik.v19i2.45301

Pendy, A., & Mbagho, H. M. (2021). Model Pembelajaran Number Head Together (NHT) pada Materi Relasi dan Fungsi. *Jurnal Basicedu, 5*(1), 165–177. https://doi.org/10.31004/basicedu.v5i1.542

Polya, G. (2004). *How to solve it: A new aspect of mathematical method* (Expanded Princeton Science Library ed.). Princeton University Press. https://press.princeton.edu/books/paperback/9780691119663/how-to-solve-it

Pratiwi, R., & Hidayati, N. (2022). Kemampuan Pemecahan Masalah Matematis Siswa Kelas XI SMK Berdasarkan Tahapan Polya. *Jurnal Educatio FKIP UNMA, 8*(1), 256–263. https://doi.org/10.31949/educatio.v8i1.1978

Rahmat, Sugita, G., & Nurhayadi. (2022). Analisis Kesalahan Siswa Kelas XI SMA Negeri 7 Palu dalam Menyelesaikan Soal Fungsi Kuadrat. *Jurnal Elektronik Pendidikan Matematika Tadulako, 9*(3), 272–280. https://jurnalfkipuntad.com/index.php/jpmt/article/view/2025

Rambe, A. Y. F., & Afri, L. D. (2020). Analisis Kemampuan Pemecahan Masalah Matematis Siswa dalam Menyelesaikan Soal Materi Barisan dan Deret. *AXIOM: Jurnal Pendidikan dan Matematika, 9*(2), 175–187. https://doi.org/10.30821/axiom.v9i2.8069

Regina, A., Patandean, A. J., & Rahmaniah. (2025). Pengaruh Model Pembelajaran Numbered Heads Together terhadap Hasil Belajar dan Kemampuan Pemecahan Masalah Matematika pada Peserta Didik di Sekolah Dasar. *Bosowa Journal of Education, 6*(1), 96–105. https://doi.org/10.35965/bje.v6i1.6177

Riansyah, M., Hardianti, D., & Asyhara, S. A. (2020). Pengaruh Model Pembelajaran Koperatif Tipe NHT terhadap Kemampuan Pemecahan Masalah Matematis Siswa.

Hipotenusa Journal of Research Mathematics Education, 3(1), 81–90. https://doi.org/10.36269/hjrme.v3i1.152

Samuel, J., Nio, T. H., & Simbolon, K. (2025). The effect of Numbered Head Together learning model assisted by learner worksheets on mathematical problem-solving ability. *EduMatSains: Jurnal Pendidikan, Matematika dan Sains, 10*(2), 1–14. https://ejournal.uki.ac.id/index.php/edumatsains/article/view/7011

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice* (2nd ed.). Allyn & Bacon.

Susanto, D., Sihombing, S. K., Radjawane, M. M., Candra, Y., & Sinambela, D. (2021). *Matematika untuk SMA/SMK kelas XI* (Edisi ke-1). Pusat Perbukuan, Badan Standar, Kurikulum, dan Asesmen Pendidikan. https://buku.kemendikdasmen.go.id/katalog/matematika-untuk-smasmk-kelas-xi