Kognitif
Jurnal Riset HOTS Pendidikan Matematika
Volume - 6 No - 2 2026 Page 669 – 681
ISSN 2776-9704 P-ISSN 2776-9984
https://doi.org/10.51574/kognitif.v6i2.4753

Effect of Wordwall-Assisted Numbered Heads Together on Junior High School Students' Mathematical Conceptual Understanding

Elviza Dwi Wahyuni, Kasman Ediputra, Adityawarman Hidayat

How to cite: Wahyuni, E. D., Ediputra, K., & Hidayat, A. (2026). Effect of Wordwall-Assisted Numbered Heads Together on Junior High School Students' Mathematical Conceptual Understanding. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *6*(2), 669–681. https://doi.org/10.51574/kognitif.v6i2.4753

To link to this artcle: https://doi.org/10.51574/kognitif.v6i2.4753

Opened Access Article

Published Online on 03 June 2026

Submit your paper to this journal

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

Effect of Wordwall-Assisted Numbered Heads Together on Junior High School Students' Mathematical Conceptual Understanding

Elviza Dwi Wahyuni[1*], Kasman Ediputra[1], Adityawarman Hidayat[1]

[1]Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Pahlawan Tuanku Tambusai

Article Info

Article history:

Received Feb 15, 2026
Accepted May 30, 2026
Published Online Jun 03, 2026

Keywords:

Conceptual Understanding
Exponents
Mathematics Learning
Numbered Heads Together
Wordwall

ABSTRACT

Students' mathematical conceptual understanding remains an important concern in junior high school mathematics learning. Inadequate conceptual understanding may lead to students' difficulties in connecting mathematical concepts and solving mathematical problems. Learning that involves collaboration and the use of interactive media is considered capable of promoting students' active engagement. This study aims to examine the effect of the Wordwall-assisted Numbered Heads Together (NHT) learning model on students' mathematical conceptual understanding of exponents. This study employed a quantitative approach with a quasi-experimental design using a nonequivalent control group design. The research subjects were Grade VIII junior high school students consisting of an experimental class and a control class. The research instrument was a mathematical conceptual understanding test developed based on four indicators: restating concepts, classifying objects, representing concepts in various forms, and applying concepts in problem solving. The data were analyzed using an independent samples t-test. The results showed a significant difference between the mathematical conceptual understanding of students taught using the Wordwall-assisted NHT model and those taught using conventional instruction. The Wordwall-assisted NHT model had a positive effect on improving students' mathematical conceptual understanding, as indicated by the higher posttest mean score of the experimental class (62.08) compared with the control class (51.68), with a Sig. (2-tailed) value of 0.007 < 0.05. These findings indicate that cooperative learning supported by interactive media can serve as a strategic alternative for improving the quality of junior high school mathematics learning.

This is an open access under the CC-BY-SA licence

Corresponding Author:

Elviza Dwi Wahyuni,
Mathematics Education Study Program,
Faculty of Teacher Training and Education,
Universitas Pahlawan Tuanku Tambusai,
Jl. Tuanku Tambusai No. 23 Bangkinang, Kampar Regency, Riau Province, Indonesia
elvizadwiwahyuni03@gmail.com

Introduction

Conceptual understanding is an essential foundation for mathematical thinking because it helps students construct structured and meaningful knowledge. A concept that is truly understood is not merely memorized but can also be restated, represented in various forms, and applied to different situations (Sengupta-irving & Agarwal, 2017). Students with strong conceptual understanding are able to connect the ideas they have learned, organize solution steps logically, and use mathematics to explain real-life problems (Kafetzopoulos & Psycharis, 2022). This condition indicates that conceptual understanding not only supports academic achievement but also develops students' critical thinking skills in everyday life. Conceptual understanding also serves as a basis for students to construct new knowledge and solve problems rationally (Byerley, 2019; Chorney et al., 2024). Effective learning helps students find meaning, connect prior knowledge with new concepts, and apply their understanding in problem-solving situations. Liljekvist et al. (2017) explain that conceptual understanding can be assessed through four indicators: restating a concept, classifying objects based on essential characteristics, representing concepts in mathematical forms, and applying concepts in problem solving.

Various international studies indicate that Indonesian students still face difficulties in mastering mathematical concepts comprehensively. Based on the 2018 Programme for International Student Assessment (PISA), the average mathematics score of Indonesian students was only 379, which was far below the Organisation for Economic Co-operation and Development (OECD) average of 489. The 2023 report from the Ministry of Education, Culture, Research, and Technology also noted that although there was a slight improvement in PISA 2022, students' mathematical reasoning and conceptual understanding remain areas that need further improvement . A national study by Qadry et al., (2022) showed that many students were still unable to meaningfully connect verbal, symbolic, and visual representations. Habibi & Suparman, (2020) further stated that students' difficulties in constructing concepts comprehensively are one of the factors that hinder the development of strong conceptual understanding.

The problem of low mathematical conceptual understanding is not only found at the national level but also in several schools in Riau. Ayu et al. (2023) found that students were only able to restate concepts and provide examples, but they were not yet able to connect concepts deeply, either internally or externally. This condition shows that students' conceptual understanding remains at a surface level and has not yet developed into meaningful understanding. This finding reinforces the need for more effective mathematics learning approaches at the local level to help students build connections among concepts and apply them comprehensively.

Preliminary observations at SMP Negeri 2 Bangkinang Kota showed that the mathematics teacher implemented the Discovery Learning model. However, in practice, classroom instruction was still dominated by lecturing, question-and-answer activities, discussion, and demonstration. This condition limited students' active engagement. The teacher stated that learning often progressed slowly because students tended to solve problems together even when the assigned problems were different. As a result, the teacher could not guide students individually in an effective way. Consequently, the learning targets for the day were delayed, and students' understanding of the concepts taught did not develop as expected. Evidence of this condition can be seen in the preliminary observation task and students' answers presented below.

https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

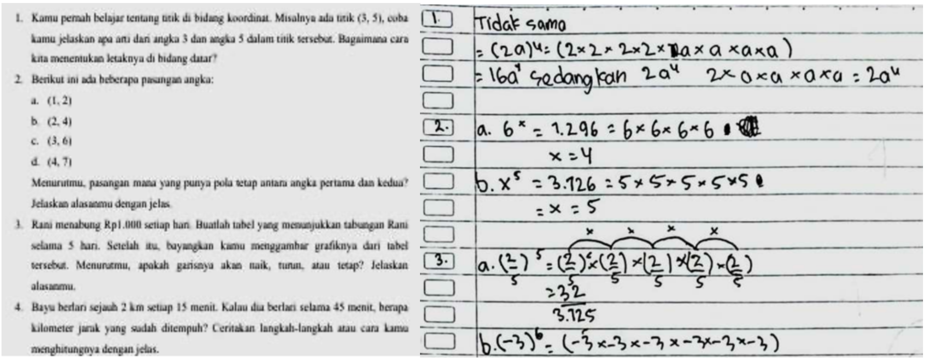

Figure 1. Preliminary Observation Task and Student Answer

The task required students to identify pairs of numbers that formed a fixed pattern and explain their reasoning. However, based on the displayed answers, some students drew a graph without plotting the appropriate points and did not provide a logical explanation. This indicates that students were not yet able to classify objects according to the requirements of a concept. In other words, the indicator of mathematical conceptual understanding related to classification had not been achieved adequately. This situation shows that limited student engagement may contribute to the low quality of their conceptual understanding.

Other indicators used in the assessment include restating concepts, representing concepts in mathematical forms, and applying concepts in problem solving. Stewart et al., (2019) emphasized that these indicators play an important role in reflecting the depth of students' understanding of a topic. These indicators do not merely assess students' ability to remember or recognize information. They also show the extent to which students are able to build connections among concepts, interpret mathematical ideas, and use concepts contextually. Therefore, these four indicators provide an important basis for designing a learning model that promotes students' active engagement and conceptual reflection.

The Numbered Heads Together (NHT) model is considered suitable for addressing students' low engagement in developing mathematical conceptual understanding (Karsidik, 2021; Rachmawati, 2023; Siregar & Wandini, 2023). According to Kurniah et al. (2018), NHT provides opportunities for all group members to participate actively, understand the material, and be ready to be randomly selected to present their answers. This structure encourages equal participation and strengthens individual learning responsibility within the group (Husnah, 2020). The implementation of NHT can be supported by Wordwall, an interactive quiz platform that provides various templates, such as quizzes and spin the wheel activities. Wordwall can serve as a supporting medium to increase students' enthusiasm during group discussions and in selecting group representatives (Nurhafsari, 2019). The integration of NHT and Wordwall is expected to create a more active and enjoyable learning environment while also improving students' mathematical conceptual understanding.

Based on the discussion above, this study examines the effect of the Wordwall-assisted Numbered Heads Together (NHT) learning model on junior high school students' mathematical conceptual understanding, particularly in the topic of exponents. This study is important because research specifically examining the integration of NHT with digital interactive media in junior high school mathematics learning remains limited, especially in relation to students' conceptual understanding. The findings of this study are expected to contribute to the design of learning that is more adaptive to students' characteristics and supports the achievement of mathematics learning objectives in schools.

Method

Research Design

This study employed a quantitative approach using a quasi-experimental method. The design used in this study was a non-equivalent control group design, which is a quasi-experimental design involving two groups without individual random assignment. The experimental group received instruction using the Wordwall-assisted Numbered Heads Together (NHT) model, whereas the control group received conventional instruction commonly used by the teacher. This design was used to examine the effect of the Wordwall-assisted NHT model on students' mathematical conceptual understanding. Both groups were given a pretest before the treatment and a posttest after the treatment. Therefore, changes in students' abilities could be compared quantitatively between the experimental and control groups.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X	O_2
Control	O_3	-	O_4

O_1 represents the pretest score of the experimental group, O_2 represents the posttest score of the experimental group, O_3 represents the pretest score of the control group, and O_4 represents the posttest score of the control group. X refers to the treatment in the form of Wordwall-assisted NHT instruction, while the symbol (-) refers to conventional instruction.

Population and Sample

The population of this study consisted of all Grade VIII students at SMP Negeri 2 Bangkinang Kota, Kampar Regency, Riau Province. The population comprised eight classes with a total of 224 students. The sample consisted of two classes selected using purposive sampling. This technique was used because the selection of classes was based on specific considerations relevant to the needs of the study. The criteria for selecting the sample included the suitability of the class with the topic being studied, the teacher's willingness to collaborate in implementing Wordwall-assisted NHT instruction, a balanced number of students across classes, and the compatibility of the class schedule with the research plan. Based on these criteria, one class was assigned as the experimental group and one class as the control group. The experimental group received Wordwall-assisted NHT instruction, while the control group received conventional instruction.

Research Instruments

The main instrument in this study was a mathematical conceptual understanding test. The test was administered as a pretest and posttest to both the experimental and control groups. It was developed in the form of essay questions to measure students' mathematical conceptual understanding of the topic being taught. The mathematical conceptual understanding test was developed based on four indicators: restating concepts, classifying objects based on essential properties or characteristics, representing concepts in various mathematical forms, and applying concepts in problem solving. The test scores were used as quantitative data to determine differences in students' mathematical conceptual understanding before and after the treatment. In addition to the test, this study also used observation sheets and documentation as supporting instruments. The observation sheet was used to observe the implementation of instruction,

https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

students' engagement, interactions among students, and students' responses to the use of Wordwall in learning. Documentation was used to support the research data, including photographs of learning activities, teacher notes, and relevant samples of students' work.

Validity and Reliability of the Instrument

Instrument validity was examined to determine the extent to which each test item measured students' mathematical conceptual understanding according to the predetermined indicators. Item validity was tested using the Pearson Product Moment correlation with the assistance of SPSS version 16. The obtained r-value for each item was compared with the r-table value at a significance level of 0.05. An item was considered valid when the obtained r-value was greater than the r-table value. The validity test results showed that all six test items had obtained r-values greater than the r-table value. The obtained r-values ranged from 0.598 to 0.877, while the r-table value was 0.3961. Thus, all test items were declared valid and suitable for measuring students' mathematical conceptual understanding.

Instrument reliability was tested using Cronbach's Alpha with the assistance of SPSS version 16. The reliability test showed a Cronbach's Alpha value of 0.820 for the six test items. This value falls into the high category, indicating that the instrument was reliable. In other words, the instrument had good consistency in measuring students' mathematical conceptual understanding. In addition to validity and reliability testing, the quality of the test items was also analyzed through item difficulty and discrimination indices. The item difficulty analysis showed that the items fell into the easy and moderate categories. Items 1, 5, and 6 were categorized as easy, while Items 2, 3, and 4 were categorized as moderate. The item discrimination analysis showed that all items were categorized as good or very good. Therefore, the instrument was considered appropriate for use in the study.

Research Procedure

The research procedure consisted of four stages. The first stage was research preparation. At this stage, the researcher prepared the learning materials, developed the pretest and posttest instruments, prepared the Wordwall media, validated the instruments, and coordinated with the school and mathematics teacher. The researcher also determined two sample classes, with one class assigned as the experimental group and the other as the control group. The second stage was the administration of the pretest. The pretest was given to students in both the experimental and control groups before the treatment was implemented. The purpose of the pretest was to determine students' initial mathematical conceptual understanding of the topic to be studied.

The third stage was the implementation of the treatment. In the experimental group, instruction was conducted using the Wordwall-assisted Numbered Heads Together (NHT) model. Wordwall was used to support group discussions, interactive quizzes, and the random selection of students through the spin the wheel feature. In the control group, instruction was conducted conventionally according to the method commonly used by the teacher, without the assistance of Wordwall. The fourth stage was the administration of the posttest. The posttest was given to students in both the experimental and control groups after the treatment had been completed. The purpose of the posttest was to determine students' mathematical conceptual understanding after the learning process. The pretest and posttest scores were then analyzed to examine the effect of the Wordwall-assisted NHT model on students' mathematical conceptual understanding.

Data Analysis

The data were analyzed using descriptive and inferential statistics. Descriptive analysis was used to describe students' mathematical conceptual understanding scores in the pretest and posttest. The data presented included the mean, minimum score, maximum score, and standard deviation. Before hypothesis testing, the data were first analyzed using prerequisite statistical tests. The normality test was used to determine whether the data came from a normally distributed population. The normality test was conducted using the Kolmogorov-Smirnov or Shapiro-Wilk test at a significance level of 0.05. The data were considered normally distributed if the significance value was greater than 0.05. Furthermore, the homogeneity test was conducted using Levene's Test to determine whether the variances of the two groups were homogeneous. The data were considered homogeneous if the significance value was greater than 0.05.

Hypothesis testing was conducted using an independent samples t-test to determine the difference in the mean mathematical conceptual understanding scores between the experimental and control groups. This test was used because the data came from two different and independent groups. The decision criterion was set at a significance level of 0.05. If the Sig. (2-tailed) value was less than 0.05, there was a significant difference between the experimental and control groups. If the Sig. (2-tailed) value was greater than or equal to 0.05, there was no significant difference between the two groups. In addition, N-Gain analysis was used to determine the improvement in students' mathematical conceptual understanding after instruction. N-Gain was calculated by comparing the difference between the pretest and posttest scores with the maximum possible improvement score. The N-Gain categories consisted of high, moderate, and low. An N-Gain value was categorized as high if $g \geq 0.70$, moderate if $0.30 \leq g < 0.70$, and low if $g < 0.30$.

Research Findings

Research Findings

The study was conducted in two Grade VIII junior high school classes, each consisting of 25 students. The experimental class received instruction using the Wordwall-assisted Numbered Heads Together (NHT) model, while the control class received regular instruction. The data analyzed in this study consisted of students' pretest and posttest scores on mathematical conceptual understanding. All data were processed using Software Staistic. The research instrument was first tested for validity and reliability. The validity test results showed that all items had obtained r-values greater than the r-table value, indicating that all items were valid. The reliability test using Cronbach's Alpha showed that the coefficient was within the reliable category, indicating that the instrument was appropriate for use in the study. The summary of the validity and reliability test results is presented in Tables 2.

Table 2. Validity Test

Item Number	Obtained r-value	r-table Value	Description
1	0.877	0.3961	Valid
2	0.689	0.3961	Valid
3	0.757	0.3961	Valid
4	0.748	0.3961	Valid
5	0.660	0.3961	Valid
6	0.598	0.3961	Valid

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

The analysis showed that all test items had obtained r-values greater than the r-table value. Therefore, all six items were declared valid. This indicates that the instrument had a strong correlational relationship with the ability being measured. Thus, all items were considered appropriate for measuring students' mathematical conceptual understanding. Furthermore, to determine the consistency of the instrument, a reliability test was conducted using Cronbach's Alpha, as presented in Table 3.

Table 3. Reliability Test

Cronbach's Alpha	Number of Items
0.820	6

The reliability coefficient of 0.820 falls into the high category. This value indicates that the instrument produced stable results when used to measure students' mathematical conceptual understanding. Therefore, the instrument was declared reliable. After the instrument was confirmed to be valid and reliable, the analysis continued with prerequisite testing, namely the normality test, to determine whether the pretest and posttest scores in both classes were normally distributed before hypothesis testing was conducted.

Table 4. Normality Test

Score	Class	Kolmogorov-Smirnov Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Result	Control Pretest	0.088	25	0.200	0.947	25	0.217
Result	Experimental Pretest	0.140	25	0.200	0.961	25	0.430
Result	Control Posttest	0.202	25	0.010	0.931	25	0.091
Result	Experimental Posttest	0.178	25	0.039	0.921	25	0.055

Based on Table 4, the normality test was interpreted using the Shapiro-Wilk test because the sample size in each class was fewer than 50 students. The significance value for the control class pretest was 0.217, while that of the experimental class was 0.430. For the posttest data, the significance value for the control class was 0.091, and that of the experimental class was 0.055. Since all significance values were greater than 0.05, the pretest and posttest data in both classes were normally distributed. This indicates that the data met one of the assumptions for parametric analysis. Therefore, the analysis proceeded to the homogeneity test to examine the equality of variances between the two classes.

Table 5. Homogeneity Test for the Control and Experimental Classes

Data	Levene's Test	df1	df2	Sig.
Pretest	3.535	1	48	0.066
Posttest	3.947	1	48	0.053

Based on Table 5, the homogeneity test using Levene's Test showed a significance value of 0.066 for the pretest and 0.053 for the posttest. Both values were greater than 0.05, indicating that the variances of the control and experimental classes were homogeneous. This means that the data distribution in both classes was relatively comparable before and after instruction. Since the homogeneity assumption was met, the analysis continued with hypothesis testing using the independent samples t-test to determine differences in students' mathematical conceptual understanding between the two classes.

Table 6. Hypothesis Testing Using the Independent Samples t-Test

Variable	Assumption	Levene's Sig.	t	df	Sig. (2-tailed)
Mathematical Conceptual Understanding	Equal variances assumed	0.053	-2.830	48	0.007
Mathematical Conceptual Understanding	Equal variances not assumed		-2.830	43.589	0.007

Based on the independent samples t-test results, the Sig. (2-tailed) value was 0.007. Since this value was less than 0.05, the null hypothesis was rejected. This means that there was a significant difference in mathematical conceptual understanding between students who learned using the Wordwall-assisted NHT model and those who learned through regular instruction. Therefore, the Wordwall-assisted NHT model had a significant effect on students' mathematical conceptual understanding.

Table 7. N-Gain Results for the Experimental and Control Classes

Class	N-Gain Score	Category
Control Class	0.2121	Low
Experimental Class	0.3935	Moderate

The improvement in students' mathematical conceptual understanding was analyzed using N-Gain. The results showed that the control class obtained an N-Gain score of 0.2121, which falls into the low category, while the experimental class obtained an N-Gain score of 0.3935, which falls into the moderate category. This difference indicates that the improvement in mathematical conceptual understanding in the experimental class was higher than that in the control class after the learning process. Based on the overall analysis, including descriptive statistics, prerequisite tests, hypothesis testing, and N-Gain analysis, the results indicate that there was a difference in mathematical conceptual understanding between the experimental and control classes. Instruction using the Wordwall-assisted Numbered Heads Together (NHT) model showed better improvement than instruction in the control class.

Discussion

The learning process in this study was designed to examine how the Wordwall-assisted Numbered Heads Together (NHT) model supported the development of students' mathematical conceptual understanding of exponents in Grade VIII. The implementation of NHT and Wordwall encouraged students to participate more actively in learning activities. Through group discussion, random student selection, and interactive tasks, students were encouraged to think, express ideas, and re-examine their understanding of the concepts being learned. The learning activities were carried out across several connected meetings. The teacher began the lesson with a brief apperception and then divided students into groups in which each member was assigned a number. This numbering system required every student to be prepared because each member had the same opportunity to be selected to answer. When Wordwall was used, the classroom atmosphere became more engaging. Students did not merely wait for their peers' answers. They began to prepare their own ideas because the questions appeared quickly, and their responses could affect the group's performance. This process helped shift learning from simply listening to interpreting concepts, constructing reasons, and justifying the solution steps they chose.

The first indicator, restating concepts, showed clear early development. Students were reintroduced to the meaning of exponents, including the concepts of base and exponent, the

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

meaning of repeated multiplication in the form a^n, and the relationships among exponent rules. At the beginning, some students tended to memorize the rules without understanding their conceptual structure. However, through group discussion, they gradually became able to explain concepts in their own words. Explanations that were initially uncertain became more organized as students corrected one another within their groups (Díaz-Berrios & Martínez-Planell, 2022). The random selection of numbered heads also encouraged students to ensure that the explanations they gave were conceptually accurate (Ferrari-Escolá et al., 2016). Thus, the ability to restate concepts became an important foundation for further conceptual understanding.

The second indicator was classifying objects based on whether they satisfied the requirements of a concept. The teacher provided various examples of exponent forms, including both valid and invalid cases. At first, students often found it difficult to distinguish which forms could be classified as exponents and which could not. After several rounds of discussion, they began to identify the characteristics of exponent forms, such as distinguishing positive and negative exponents and differentiating exponents from roots, algebraic forms, or fractions that did not meet the intended concept. Wordwall supported this process by providing quick classification tasks that trained students to make decisions more accurately (Nisa & Susanto, 2022). Students also began to give reasons for why a form belonged to a particular category rather than choosing answers randomly. This development indicates that students began to understand the formal requirements of a concept rather than merely remembering examples presented by the teacher.

The third indicator was representing concepts in various mathematical forms. Students were guided to express exponent concepts through repeated multiplication patterns, simple tables, fractional forms for negative exponents, and other basic representations. Some students initially experienced difficulties because representation required them to transform abstract ideas into more visible forms. However, group discussion allowed them to identify and correct errors in their representations. Wordwall also helped students recognize repeated patterns across several problems. For example, some students who initially struggled to connect exponent forms with fractional forms became more familiar with these relationships after seeing repeated patterns in the tasks. This process strengthened students' conceptual understanding because they did not only recognize the concept symbolically, but also understood how the concept could be represented in equivalent forms (Byerley, 2019).

The fourth indicator, applying concepts in problem solving, was the most challenging but showed noticeable improvement toward the end of the learning process. Students were given simple contextual problems that required the use of exponent rules. Initially, many students depended heavily on examples. However, through group discussion, they learned to interpret the problem, select the appropriate exponent rule, and organize the solution steps correctly. The NHT model required each group member to be ready to respond, so students could not rely only on one dominant member (Siregar & Wandini, 2023). Wordwall also encouraged students to check their work more carefully because scores were displayed directly and group performance became visible. As a result, students became more attentive in applying concepts and more responsible for the answers they presented.

The four indicators of conceptual understanding developed at different rates. The ability to restate concepts and represent concepts improved gradually but consistently, as students needed time to organize their explanations and connect one form of representation with another. Meanwhile, the ability to classify objects and apply concepts showed faster development because these indicators were strongly supported by group discussion in NHT and by Wordwall tasks that required students to make decisions based on reasons rather than guesses (Rachmawati, 2023). This finding suggests that the learning model did not affect all indicators in the same way. Instead, it supported students' conceptual understanding gradually according to the nature of each learning activity.

The classroom learning process was consistent with the statistical findings. The relatively low pretest scores in both classes indicated that students began with limited initial understanding. However, the higher posttest scores in the experimental class compared with the control class indicate that Wordwall-assisted NHT did not only create more engaging learning activities but also supported students' conceptual development. The independent samples t-test showed a significance value below 0.05, indicating a significant difference between the experimental and control classes. This finding suggests that the learning experiences provided through Wordwall-assisted NHT contributed to measurable improvement in students' mathematical conceptual understanding.

The N-Gain results further support this interpretation. The experimental class obtained an N-Gain score in the moderate category, while the control class obtained an N-Gain score in the low category. This difference indicates that students who learned through the Wordwall-assisted NHT model experienced greater improvement than those who learned through conventional instruction. However, because the N-Gain score of the experimental class was still in the moderate category, the findings should be interpreted carefully. The model had a positive effect, but the improvement had not yet reached a high level. This suggests that longer implementation, more varied tasks, and stronger conceptual reflection may be needed to produce greater learning gains.

The effectiveness of Wordwall-assisted NHT can be understood from the interaction between cooperative learning and interactive media. NHT encouraged individual responsibility within group learning because each student had the same chance to be selected to answer. This structure reduced passive participation and encouraged students to prepare their own understanding. Wordwall added an interactive element that increased students' engagement, provided immediate stimulation through quiz-based activities, and made the learning process more dynamic (Nisa & Susanto, 2022). The combination of these two components created a learning environment that supported discussion, conceptual clarification, and student participation.

These findings are consistent with previous studies showing that cooperative learning can improve students' conceptual understanding by encouraging active participation, peer explanation, and shared responsibility in learning (Chorney et al., 2024). The structure of NHT enables students to discuss concepts collaboratively while still maintaining individual accountability because each student has the possibility of being selected to represent the group (Karsidik, 2021). This supports students in restating concepts, clarifying misconceptions, and justifying their answers. In addition, the use of Wordwall strengthens the learning process by providing interactive tasks that increase students' engagement and help them receive immediate feedback during learning activities. Therefore, the findings of this study reinforce the view that combining cooperative learning with digital interactive media can create a more supportive environment for developing students' mathematical conceptual understanding, particularly in learning exponents at the junior high school level (Alqahtani & Powell, 2017).

Overall, the findings indicate that the Wordwall-assisted Numbered Heads Together (NHT) model had a positive effect on students' mathematical conceptual understanding. The model helped students not only restate definitions and properties of exponents, but also classify objects, represent concepts, and apply concepts in problem-solving situations. The sequence of group discussion, Wordwall activities, random selection of numbered heads, and brief reflection at the end of the lesson provided students with learning experiences that supported a deeper understanding of exponent concepts.

https://doi.org/10.51574/kognitif.v6i2.4753 Volume 6, No 2, April - June 2026, pp. 669 – 681

Conclusion

Based on the results of the study, it can be concluded that the Wordwall-assisted Numbered Heads Together (NHT) learning model had a positive effect on junior high school students' mathematical conceptual understanding of exponents. Students in the experimental class showed better improvement than those in the control class. This was indicated by the significant difference in posttest scores between the two classes and the higher N-Gain score obtained by the experimental class. The implementation of the Wordwall-assisted NHT model supported students in developing the four indicators of mathematical conceptual understanding. Students became more capable of restating concepts, classifying mathematical objects based on their properties, representing concepts in different mathematical forms, and applying concepts in problem-solving situations. The NHT structure encouraged students to take individual responsibility within group learning, while Wordwall increased students' engagement through interactive activities. These findings indicate that combining cooperative learning with digital interactive media can create a more active and supportive mathematics learning environment. Therefore, the Wordwall-assisted NHT model can be used as an alternative instructional strategy to improve students' mathematical conceptual understanding, particularly in learning exponents at the junior high school level. Further studies may apply this model to other mathematical topics, involve larger samples, and examine its long-term effect on students' conceptual understanding.

Conflict of Interest

The authors declare that there is no conflict of interest.

Auhor Contributions

Author E.D.W. contributed to the development of instruments, research design, understanding of theoretical foundations, data collection and processing, data analysis, presentation of results and discussion, revision, and ensuring the consistency of the entire article. Author K.E. contributed to the development of theoretical studies and approved the final manuscript. Author A.H. contributed to the development of the theory and approved the final version of the article. The total percentage of author contributions to the conceptualization, drafting, and correction of this article is: E.D.W.: 40%, K.E.: 30%, and A.H.: 30%.

Data Availability Statement

The authors declare that the data supporting the findings of this study will be made available by the corresponding author, [E.D.W.], upon reasonable request.

References

Alqahtani, M. M., & Powell, A. B. (2017). Mediational activities in a dynamic geometry environment and teachers' specialized content knowledge. *Journal of Mathematical Behavior*, *48*(February), 77–94. https://doi.org/10.1016/j.jmathb.2017.08.004

Ayu, N. M., Hamdani, H., Sahputra, R., Rif'at, M., & Suratman, D. (2023). Komunikasi matematis lisan, pemahaman konseptual dan motivasi belajar dalam pembelajaran matematika menggunakan media quizizz. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(3). https://doi.org/10.24127/ajpm.v12i3.7207

Byerley, C. (2019). Calculus students' fraction and measure schemes and implications for teaching rate of change functions conceptually. *Journal of Mathematical Behavior*, *55*(March), 0–1. https://doi.org/10.1016/j.jmathb.2019.03.001

Chorney, S., Evans, K. R., & Staples, M. (2024). Conceptualizing reasoning practices in the context of sociomathematical issues. *Journal of Mathematical Behavior*, *73*. https://doi.org/10.1016/j.jmathb.2024.101124

Díaz-Berrios, T., & Martínez-Planell, R. (2022). High school student understanding of exponential and logarithmic functions. *Journal of Mathematical Behavior*, *66*(April). https://doi.org/10.1016/j.jmathb.2022.100953

Ferrari-Escolá, M., Martínez-Sierra, G., & Méndez-Guevara, M. E. M. (2016). "Multiply by adding": Development of logarithmic-exponential covariational reasoning in high school students. *Journal of Mathematical Behavior*, *42*, 92–108. https://doi.org/10.1016/j.jmathb.2016.03.003

Habibi, H., & Suparman, S. (2020). Literasi Matematika dalam Menyambut PISA 2021 Berdasarkan Kecakapan Abad 21. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *6*(1), 57. https://doi.org/10.30998/jkpm.v6i1.8177

Husnah, A. (2020). Efektivitas Penerapan Model Kooperatif Tipe Numbered Heds Together (NHT) Dalam Pembelajaran Matematika Siswa. *ELIPS: Jurnal Pendidikan Matematika*, *1*(1). https://doi.org/10.47650/elips.v1i1.123

Kafetzopoulos, G. I., & Psycharis, G. (2022). Conceptualization of function as a covariational relationship between two quantities through modeling tasks. *Journal of Mathematical Behavior*, *67*(July), 100993. https://doi.org/10.1016/j.jmathb.2022.100993

Karsidik, K. (2021). Peningkatan hasil belajar matematika tentang pecahan melalui model pembelajaran nht (numbered head together) pada siswa kelas V SD Negeri Bulang II tahun pelajaran 2018/2019. *Pedagogy : Jurnal Ilmiah Ilmu Pendidikan*, *8*(1). https://doi.org/10.51747/jp.v8i1.699

Kurniah, N., Basir, F., & Ikram, M. (2018). Pola Interaksi Dalam Belajar Matematika Berdasarkan Kemampuan Awal Melalui Pembelajaran Kooperatif. *Proximal: Penelitian Matematika Dan Pendidikan Matematika*, *1*(1), 65–74. https://www.e-journal.my.id/proximal/article/view/188,

Liljekvist, Y., Mellroth, E., Olsson, J., & Boesen, J. (2017). Conceptualizing a Local Instruction Theory in Design Research: Report from a Symposium. *Swedish Society for Research in Mathematics Education*, 119–128. http://ncm.gu.se/media/smdf/Published/No11_Madif10/119128_madif_SY003_liljekvist.pdf

Nisa, M. A., & Susanto, R. (2022). Pengaruh Penggunaan Game Edukasi Berbasis Wordwall Dalam Pembelajaran Matematika Terhadap Motivasi Belajar. *JPGI (Jurnal Penelitian Guru Indonesia)*, *7*(1). https://doi.org/10.29210/022035jpgi0005

Nurhafsari, A. (2019). Kemandirian Belajar Matematika Siswa dalam Pembelajaran Kooperatif dengan Aktivitas Quick on The Draw. *GAUSS: Jurnal Pendidikan Matematika*, *1*(2). https://doi.org/10.30656/gauss.v1i2.1051

Qadry, I. K., Dessa, A., & Aynul, N. (2022). Analisis Kemampuan Literasi Matematika Siswa Dalam Menyelesaikan Soal Pisa Konten Space and Shape Pada Kelas IX SMP Negeri 13 Makassar. *Jurnal Matematika Dan Aplikasinya*, *2*(2). https://doi.org/10.30605/27458326-99

Rachmawati. (2023). Peningkatan Hasil Belajar Matematika tentang Pecahan Melalui Model Pembelajaran NHT (Numbered Head Together) pada Siswa Kelas V SD Negeri Tegalsiwalan 1. *PEDAGOGY*, *10*(1). https://doi.org/10.46229/elia.v3i2.670

Sengupta-irving, T., & Agarwal, P. (2017). Conceptualizing Perseverance in Problem Solving as Collective Enterprise Conceptualizing Perseverance in Problem Solving as Collective. *Mathematical Thinking and Learning*, *19*(2), 115–138. https://doi.org/10.1080/10986065.2017.1295417
Siregar, R. F., & Wandini, R. R. (2023). Penerpan Model Pembelajaran Kooperatife Tipe Nht (Numbered Heads Together) Dalam Pembelajaran Matematika di SD Subsidi Swakarya. *Jurnal Pendidikan Tambusai*, *7*. https://doi.org/10.31004/jptam.v7i3.11948
Stewart, S., Troup, J., & Plaxco, D. (2019). Reflection on teaching linear algebra: examining one instructor's movements between the three worlds of mathematical thinking. *ZDM - Mathematics Education*, *51*(7), 1253–1266. https://doi.org/10.1007/s11858-019-01086-0

Authors Biography

	**Elviza Dwi Wahyuni** was born in Bangkinang on March 14, 2003. She began her education at SDN 005 Langgini and graduated in 2015. She then continued her studies at SMPN 2 Bangkinang Kota and graduated in 2018. She later attended SMAN 2 Bangkinang Kota and graduated in 2021. She pursued higher education at Universitas Pahlawan Tuanku Tambusai, a private university, and graduated in 2025. ✉ elvizadwiwahyuni03@gmail.com
	**Kasman Ediputra** is a lecturer in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Pahlawan Tuanku Tambusai. ✉ ediputra051283@gmail.com
	**Adityawarman Hidayat** is a lecturer in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Pahlawan Tuanku Tambusai. ✉ adityawarmanhidayat89@gmail.com