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The effect of the discovery learning model on fourth-grade students' understanding of mathematical concepts

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ABSTRACT

Elementary school students' low understanding of mathematical concepts is a challenge in the learning process. In the context of the Independent Curriculum, which encourages active and student-centered learning, a learning model that can increase engagement and independence in learning is needed. This study aims to investigate the effect of the Discovery Learning model on the understanding of mathematical concepts of fourth-grade students in Kupang City. Using a quantitative approach with a quasi-experimental method, this study involved two groups: an experimental group that received learning using the Discovery Learning model, and a control group that was taught using the expository method. The research instrument was a conceptual understanding test developed to measure mastery of the material before and after treatment. Data analysis was carried out using the Shapiro-Wilk normality test and the non-parametric Mann-Whitney U test. The test results showed a significance value, indicating a significant difference between student learning outcomes in the two groups. This means that the Discovery Learning model positively contributes to improving students' understanding of mathematical concepts. Further research is recommended to examine the long-term impact of implementing this model and its effectiveness in various mathematical topics and different educational environments.

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ABSTRAK

Rendahnya pemahaman konsep Matematika peserta didik sekolah dasar menjadi sebuah tantangan dalam proses pembelajaran. Dalam konteks Kurikulum Merdeka yang mendorong pembelajaran aktif dan berpihak pada peserta didik dibutuhkan model pembelajaran yang dapat meningkatkan keterlibatan dan kemandirian belajar. Penelitian ini bertujuan untuk menyelidiki pengaruh model Pembelajaran Penemuan terhadap pemahaman konsep Matematika peserta didik kelas IV di Kota Kupang. Menggunakan pendekatan kuantitatif dengan metode kuasi-eksperimental, penelitian ini melibatkan dua kelompok: kelompok eksperimen yang mendapatkan pembelajaran menggunakan model Pembelajaran Penemuan, dan kelompok kontrol yang diajar dengan metode ekspositori. Instrumen penelitian berupa tes pemahaman konsep yang dikembangkan untuk mengukur penguasaan materi sebelum dan sesudah perlakuan. Analisis data dilakukan melalui uji normalitas Shapiro-Wilk dan uji non-parametrik Mann-Whitney U. Hasil uji menunjukkan nilai signifikansi, yang mengindikasikan adanya perbedaan yang signifikan antara hasil belajar peserta didik di kedua kelompok. Hal ini berarti bahwa model Pembelajaran Penemuan secara positif berkontribusi terhadap peningkatan pemahaman konsep Matematika peserta didik. Penelitian lanjutan disarankan untuk meninjau dampak jangka panjang dari penerapan model ini serta efektivitasnya dalam berbagai topik Matematika dan lingkungan pendidikan yang berbeda.

Kata Kunci: *model discovery learning; pemahaman konsep Matematika; sekolah dasar*

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INTRODUCTION

Education is a vital investment in human civilization because it enables the transmission of cultural values, knowledge, and skills from one generation to the next. Education serves not only as a means of knowledge transfer but also as a tool for shaping character and moral values that form the foundation of a civilized society. Through the educational process, societies can optimally develop their human resources' potential, enabling them to face various social, economic, and cultural challenges. Along with the progression of time and changes in the global environment, the role of education has expanded. Education in the 21st century faces a significant challenge in preparing students with global competencies that align with the demands of the modern world. These global competencies encompass six core skills critical thinking, creativity, cultural awareness, collaboration, communication, and connectivity collectively referred to as the 6Cs (Dignam, 2025). These six competencies do not emerge instantly but must be gradually developed through a systematically designed learning process in schools. As the Partnership for 21st Century Learning Frameworks & Resources states that Mathematics is one subject that plays a significant role in cultivating and fostering the 6Cs (Critical thinking, Creativity, Collaboration, Communication, Citizenship, and Character) (retrieved from: https://battelleforkids.org/networks/p21). Mathematics is taught from elementary to secondary school as part of the government's effort to enhance the quality of education, as outlined in Permendikbud Ristek No. 7 of 2022 (retrieved from: https://peraturan.bpk.go.id/Details/224179/permendikbudriset-no-7-tahun-2022).

Mathematics has a significant role in the development of science and everyday life. This subject teaches calculations and formulas, fostering critical, logical, creative, and innovative thinking skills (Bayore & Cajandig, 2025). Mathematics is a science that emphasizes the organization of patterns, relationships between concepts, and logical proof in various fields, including algebra, geometry, and analysis. In learning Mathematics, students develop an understanding of facts, concepts, and principles through learning experiences tailored to their abilities, where the teacher serves as a facilitator (Wibowo et al., 2024). Introducing Mathematics early, especially at the elementary school level, prepares students to face real-life problems (Anisa et al., 2020). Learning math early can develop numeracy skills, foster a structured mindset, train critical reasoning, and aid in daily activities such as buying and selling transactions. In addition, Mathematics also forms perseverance, patience, and thoroughness (Triyono et al., 2025). Aprilia et al. in their book entitled *"Pembelajaran Matematika sekolah dasar dengan model dan media inovatif"* also state that other Mathematics learning objectives include developing ways of thinking and reasoning in concluding, increasing creativity through intuition and discovery, and improving the ability to solve problems and communicate ideas in various forms.

In the Kurikulum Merdeka, Mathematics learning is designed with clear objectives aimed at nurturing students' cognitive abilities, reasoning skills, and positive dispositions. These objectives emphasise not only understanding mathematical facts, concepts, and procedures but also applying them effectively to solve problems. Logical reasoning plays a crucial role, enabling students to analyse patterns, make generalisations, and construct proofs. Moreover, students are encouraged to solve problems through a systematic approach, from comprehending the problem to designing mathematical models and interpreting the solutions. Communication is also fundamental, with learners expressing ideas using symbols, tables, diagrams, and various media to represent mathematical situations. As the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia states, the curriculum further emphasizes the importance of connecting mathematical concepts across scientific disciplines and real-life contexts. Equally important is fostering positive attitudes toward Mathematics, such as curiosity, creativity, independence, perseverance, and self-confidence (retrieved from: https://kurikulum.kemdikbud.go.id/wp-content/unduhan/CP_2022.pdf).

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At the elementary school level, these comprehensive goals translate into concrete learning activities tailored to young learners. Students engage in exploring patterns and relationships, which help them investigate and understand the connections between concepts. Creativity is nurtured through tasks that involve imagination, intuition, and discovery, while problem-solving exercises encourage logical, systematic, and consistent thinking. As Hastuti et al. in their book entitled *"Pembelajaran Matematika sekolah dasar"* state that Mathematics is also employed as a powerful communication tool, allowing students to convey their ideas clearly and interpret mathematical representations meaningfully. The curriculum's goals and the corresponding learning activities form a coherent framework that guides teaching and learning in elementary Mathematics. Ensuring alignment between these objectives and classroom practices is essential for developing students' conceptual understanding, higher-order thinking skills, and positive dispositions toward Mathematics. This alignment highlights the importance of effective instructional models, such as Discovery Learning, which actively engage students in constructing knowledge and promote both their cognitive and affective growth in Mathematics education.

However, observations and interviews in Kupang indicate that a teacher-centred approach still predominates in Mathematics learning. The teacher is the only source of information and the principal director of education. This causes students to be passive, not fully understand concepts, and view math as a scary and challenging lesson. The dominant methods include lectures, question-and-answer sessions, practice problems, and expository discussions. This type of learning pattern has not encouraged students to build their understanding actively. Additionally, learners can only repeat concepts verbally without fully understanding their meaning or explaining them in their own words. Many learners have not mastered the prerequisite material and are unable to solve simple arithmetic operation problems, despite being familiar with mathematical symbols.

The results of observations and interviews indicate that students' conceptual understanding of Mathematics remains low. Concept understanding is fundamental as a foundation for achieving optimal learning outcomes and as a provision for solving various mathematical problems (Novitasari, 2016). This deficiency can impact the learning process at the next level due to the interconnected nature of mathematical material. Students aged 6-12 years generally exhibit characteristics that include a desire to move, play, work in groups, and engage in hands-on demonstrations (Mutia, 2021). Considering these characteristics, learning should be fun and interactive, allowing students to actively participate in group and project activities. Teachers' understanding of learners' characteristics is very influential in choosing appropriate learning strategies, methods, and models (Agustrianita et al., 2019).

Learning strategies can be adapted to the characteristics of the material, such as learning outside the classroom, group-based learning, the use of educational games, or other activities that involve students' active participation. Some teachers are starting to implement digitalization in learning, but most of the process still takes place conventionally in the classroom. Since each Mathematics topic has distinct characteristics, not all materials can be taught using the same approach (Mania & Adam, 2021). Therefore, piloting a particular learning model to determine its effect on improving students' concept understanding and learning independence is essential. One of the relevant and potentially useful models to consider is the Discovery Learning model.

The Discovery Learning model is a learning approach that allows students to independently discover concepts, meanings, and relationships between materials through an exploratory process (Khasinah, 2021). The discovery-based approach can support students in understanding and analyzing creative thinking processes and decision-making (Josephine et al, 2016). This model offers several advantages, including encouraging students to construct knowledge independently, strengthening conceptual understanding, developing higher-order thinking skills, increasing engagement and autonomy in learning, and creating meaningful learning experiences (Aldiyansyah et al., 2024; Gunawan et al., 2024; Mumtaza et al., 2024; Puspitasari & Nurhayati, 2019; Trianingsih et al., 2019). Based on the guidelines from

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Kementrian Pendidikan dan Kebudayaan, the Discovery Learning model consists of six essential stages: providing a stimulus, identifying problems, collecting data, processing data, verifying, and drawing conclusions (Khasinah, 2021). Each stage is designed to encourage students' active participation and enhance their independent thinking skills and deeper conceptual understanding.

Despite its potential, empirical studies that examine the impact of Discovery Learning on both conceptual understanding and learning independence at the elementary level remain limited. Most existing research focuses on secondary or higher education, with minimal attention to younger students who are still developing abstract reasoning skills. Furthermore, few studies combine both cognitive (conceptual understanding) and dispositional (learning independence) outcomes in a single intervention. This gap is particularly evident in under-resourced areas such as Kupang, where traditional teaching methods still dominate.

Therefore, this study aims to address this gap by examining the impact of the Discovery Learning model on the conceptual understanding of fourth-grade students in Mathematics, particularly about topics involving Picture Patterns and Number Patterns. This topic was selected due to its abstract nature and alignment with the higher-order thinking goals of the Kurikulum Merdeka. By evaluating the implementation of Discovery Learning in this specific context, this research aims to provide empirical evidence of how constructivist approaches can support both conceptual understanding and learner autonomy.

This study makes a novel contribution by integrating cognitive and dispositional learning outcomes within a single instructional model, situating the research within the framework of Indonesia's curriculum reform. It also presents practical implications for improving Mathematics instruction in elementary schools, particularly in underserved educational contexts. Therefore, this research aims to examine the effect of the Discovery Learning model on the conceptual understanding of fourth-grade students in Mathematics, particularly regarding number patterns and sequences, in line with the objectives of the Kurikulum Merdeka.

LITERATURE REVIEW

Discovery Learning Model

The Discovery Learning model is a learning approach that actively engages students in the learning process through exploratory activities, leading to the discovery of concepts, principles, or relationships among materials. This model positions students as the central agents in the learning process, aiming to cultivate their ability to think critically, analytically, and creatively in constructing knowledge independently. Discovery Learning is designed to foster active, innovative, and independent learning behaviors by providing students with ample opportunities to construct their understanding through cognitive engagement and discovery (Nurdin et al., 2019). The core principle underlying this model is constructivism, which posits that knowledge is not transmitted directly by the teacher but is instead actively constructed by learners through meaningful learning experiences. In this context, the teacher serves as a facilitator, guiding students in their pursuit of understanding and knowledge. This process relies on students' abilities to observe phenomena, formulate questions, gather and process data, and draw conclusions based on the outcomes of their exploration (Khasinah, 2021).

The stages of Discovery Learning follow the framework outlined in Permendikbud Ristek No. 58 of 2014 (retrieved from: https://peraturan.go.id/id/permendikbud-no-58-tahun-2014), which comprises six systematic steps: 1) providing a stimulus, 2) identifying problems, 3) collecting data, 4) processing data, 5) verifying findings, and 6) drawing conclusions. These stages are designed to cultivate higher-order thinking skills and encourage students to become active learners who can construct knowledge through direct experience. According to Pranoto, as cited in Nababan et al. (2023), Discovery Learning possesses

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several distinctive characteristics. It emphasizes exploration and problem-solving as pathways to deep conceptual understanding, promotes the integration of new and prior knowledge, and supports learners' initiative and independence. Furthermore, assessment within this model is authentic, focusing on students' performance throughout the learning process rather than solely on outcomes.

Discovery Learning also offers various advantages that contribute to the enhancement of instructional quality. As noted by Hosman, its benefits include: 1) fostering critical thinking and cognitive development; 2) reinforcing long-term conceptual retention; 3) enhancing students' ability to solve problems independently and creatively; 4) promoting social interaction and collaboration, which in turn support the development of positive self-concept; and 5) cultivating sustainable independent learning habits (Moko et al., 2022). Given these strengths, the Discovery Learning model is particularly well-suited for Mathematics education, especially for abstract topics that require higher-order thinking, such as number patterns and sequences. In the context of the Kurikulum Merdeka, which emphasizes differentiated instruction and learner autonomy, Discovery Learning emerges as a promising pedagogical approach to improve conceptual understanding while also supporting the affective development of students in Mathematics learning.

Understanding of Mathematical Concepts

Conceptual understanding refers to students' ability to interpret, recall, and explain a topic accurately. Within the cognitive domain, conceptual understanding (C2) involves the mastery of both remembering (C1) and comprehending (C2). It is a mental process that requires deep thinking to construct meaning from a concept (Nurhangesti & Seruni, 2024). In Mathematics, conceptual understanding is crucial, as it allows students to construct knowledge independently and express it using their reasoning. The subject emphasizes the interconnectivity and continuity of concepts, requiring a strong foundation for progressing to more advanced material (Muslina, 2017). Without this foundation, students may encounter difficulties when solving problems or applying mathematical knowledge to real-world contexts.

To evaluate conceptual understanding, educators commonly use assessments that align with institutional benchmarks such as the Minimum Completion Criteria (*Kriteria Ketuntasan Minimal/KKM*). Based on Bloom's taxonomy, understanding occupies the second level of cognition and serves as a prerequisite for higher-order thinking (Nafiati, 2021). Permendikbud No. 58 tahun 2014 outlines several indicators of conceptual understanding, including the ability to restate and classify concepts, identify attributes, apply and represent ideas, provide examples and non-examples, and integrate mathematical concepts across disciplines. However, students' mastery of conceptual understanding is shaped by multiple factors. Internally, variables such as interest, motivation, and cognitive ability play a role (Rosyiddin et al., 2023). Externally, teacher quality, instructional strategies, curriculum design, facilities, and the learning environment all significantly influence students' outcomes (Khaira et al., 2023; Sukmawati, 2017).

METHODS

This study employed a quasi-experimental method with a Nonequivalent Control Group Design, consisting of pre-test and post-test procedures to examine the effect of the Discovery Learning model on students' conceptual understanding in the topic Picture Patterns and Number Patterns. The research involved two groups: an experimental group that received treatment using the Discovery Learning model, and a control group that was taught through the expository models. The research subjects consisted of 42 fourth-grade students from an elementary school in Kupang City, with 21 students in Class IV A designated as the experimental group and 21 students in Class IV B as the control group (see **Table 1**). These classes were

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selected based on their similarity in the number of students and average Mathematics scores, ensuring a balanced comparison between the two groups.

Table 1. Research Population

Explanation	Class	Model	Total Students
IV A	Experiment	Discovery Learning	21
IV B	Control	Expository	21

Sources: Research 2025

Before the treatment, both groups were given a pre-test to assess their initial understanding of mathematical concepts. The test instrument was developed based on relevant learning objectives and was validated by Mathematics education experts to ensure its content validity. Following the pre-test, the experimental group underwent a series of learning sessions using the Discovery Learning model, while the control group followed the conventional expository approach. The learning materials, time allocation, and instructional goals were kept consistent across both groups to isolate the impact of the instructional method. After the learning sessions were completed, both groups were administered a post-test to measure the improvement in their conceptual understanding. The data collected from the pre-test and post-test were then analyzed using descriptive and inferential statistics. Normality was assessed using the Shapiro-Wilk test, while the Mann-Whitney U test was employed to test the research hypothesis due to the non-normal distribution of the data. All statistical analyses were conducted with the assistance of SPSS software. This systematic approach was designed to ensure that any observed differences in students' conceptual understanding could be attributed to the learning model applied during the study.

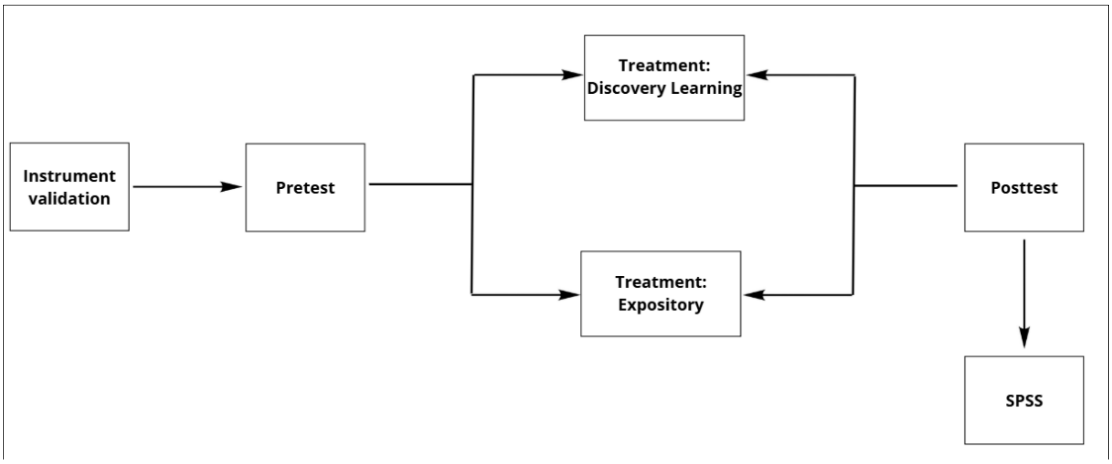

Figure 1. Research Flow
Sources: Research 2025

The research methodology employed a quasi-experimental design with a pre-test and post-test procedure to investigate the impact of different instructional models. According to **Figure 1** the study began with an essential phase of instrument validation to ensure the reliability and validity of the assessment tools. Following this, both the experimental and control groups administered a pre-test to establish a baseline of their conceptual understanding. The core of the study involved a treatment phase, where the experimental group was taught using the Discovery Learning model, and the control group was instructed using the Expository method. After the treatment period, a post-test was administered to both groups to measure the changes in their conceptual understanding. Finally, the data from the pre-test and post-test were analyzed using SPSS software to determine the statistical significance of the findings, allowing for a comparison of the effectiveness of the two teaching models.

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RESULTS AND DISCUSSION

As revealed through the test results, to gauge proficiency in grasping mathematical concepts, the data description is explained as follows: pre-test and post-test data on understanding mathematical concepts were collected at the beginning and end of the learning period in both experimental and control classes. Presented below is a comparison of conceptual understanding results between the control and experimental groups.

Table 2. Statistical Description of Understanding of Mathematical Concepts

Statistical Description					
	N	**Min**	**Max**	**Mean**	**Std. Deviasi**
Pretest_ Experiment	21	5.00	66.00	20.4762	16.93405
Posttest_Exsperiment	21	10.00	80.00	52.3333	18.36119
Pretest_Control	21	.00	49.00	13.8095	12.20500
Posttest_Control	21	6.00	73.00	35.9048	19.45740
Valid N (listwise)	21				

Sources: Research 2025

The descriptive statistical analysis of students' mathematical conceptual understanding, as shown in **Table 2**, reveals a notable difference between the experimental and control groups. The pretest results of the experimental group, which was taught using the Discovery Learning model, show a mean score of 20.48 with a standard deviation of 16.93, indicating that students' initial understanding of the material was relatively low and varied. However, after the intervention, the posttest mean score increased significantly to 52.33, with a slightly higher standard deviation of 18.36, suggesting a substantial improvement in conceptual understanding, albeit with some variation in individual performance. In contrast, the control group, which received instruction through the expository method, recorded a lower pretest mean of 13.81 with a standard deviation of 12.21. Following the intervention, the posttest mean increased to 35.90, accompanied by a standard deviation of 19.45. While a positive change was observed in this group, the improvement was not as substantial as that of the experimental group. Overall, the data indicate that both groups showed progress in understanding mathematical concepts after instruction. However, the experimental group demonstrated a greater average gain of 31.85 points, compared to 22.09 points in the control group. These results suggest that the Discovery Learning model had a more pronounced impact on enhancing students' conceptual understanding in Mathematics, particularly in the topic of Picture Patterns and Number Patterns.

The subsequent phase of data analysis involved conducting a normality test to assess whether the students' mathematical concept comprehension scores in both the experimental and control groups followed a normal distribution. The Shapiro-Wilk Test was selected for this purpose, given the sample size was fewer than 50 participants. Data are deemed normally distributed if the significance value exceeds 0.05; otherwise, a significance value below this threshold indicates a departure from normality. The detailed results of the normality assessment are provided below.

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Table 3. Normality Test Results of Understanding of Mathematical Concepts

Test of Normality						
	Kolmogorov-Smirnov			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pretest_ Experiment	.297	21	< .001	.753	21	< .001
Posttest_Experiment	.090	21	.200	.965	21	.631
Pretest_Control	.318	21	< .001	.773	21	< .001
Posttest_Control	.127	21	.200	.959	21	.497

Sources: Research 2025

The normality test results in **Table 3** revealed that the pretest scores in both the experimental and control groups did not follow a normal distribution, with significance levels of 0.01. In contrast, the post-test scores of the control group yielded a significance value of 0.497, indicating normal distribution of the data. This non-normality in the pretest scores is considered acceptable, given the sample size was below 50, as smaller samples often exhibit deviations from normality. The skewness observed likely reflects an uneven distribution of scores around the mean.

Due to the data's deviation from a normal distribution, the application of a non-parametric statistical method was considered most suitable. Accordingly, the Mann-Whitney U Test was employed to examine the differences in post-test scores between the experimental and control groups. A p-value below the 0.05 threshold indicates a statistically significant disparity between the groups, while a value above this threshold implies the absence of a significant difference. The detailed outcomes of the Mann-Whitney U Test are presented in the subsequent section.

Table 4. Mann-Whitney U Results of Math Concept Understanding Ability

Ranks				
Posttest	Class	N	Mean Rank	Sum of Ranks
	Experiment Class	21	26.05	547.00
	Control Class	21	16.95	356.00
	Total	42		

Test Statistics	
	Posttest
Mann-Whitney U	125.000
Wilcoxon W	356.000
Z	-2.404
Asymp. Sig (2-tailed)	.016

Sources: Research 2025

The Mann-Whitney U Test in **Table 4** yielded an Asymptotic Significance (two-tailed) value of 0.016, which falls below the 0.05 significance level, indicating a statistically significant difference in post-test scores between the experimental and control groups. **Table 5** shows that a homogeneity test was performed to evaluate the equality of variances in students' understanding of mathematical concepts. This step is critical to verify whether the data originate from populations with comparable variance levels. Levene's Test was employed to assess this assumption, whereby a significance value greater than 0.05 denotes homogeneity

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of variances. The outcomes of Levene's Test on the variable of mathematical concept comprehension are detailed on **Table 5**.

Table 5. Homogeneity test of Understanding of Mathematical Concepts

Test of Homogeneity of Variance					
		Levene Statistic	**df1**	**df2**	**Sig.**
Understanding of Mathematical Concepts	Based on Mean	.349	1	40	.558
	Based on Median	.245	1	40	.623
	Based on Median and with adjusted df	.245	1	39.969	.623
	Based on trimmed mean	.368	1	40	.547

Sources: Research 2025

Referring to **Table 5**, the significance value based on the mean for students' understanding of mathematical concepts is 0.558. Since 0.558 exceeds the 0.05 threshold, it can be concluded that the post-test data from both the experimental and control groups are homogeneous. Additionally, a test was conducted to assess students' initial abilities and prior understanding of mathematical concepts in both groups. The results of this assessment are presented in the following table.

Table 6. Test of initial ability to understand mathematical concepts

Ranks				
	Class	**N**	**Mean Rank**	**Sum of Ranks**
Pretest Understanding of Mathematical Concepts	Experiment Class	21	26.05	547.00
	Control Class	21	16.95	356.00
	Total	**42**		

Test Statistics	
	Pretest Understanding of Mathematical Concepts
Mann-Whitney U	125.000
Wilcoxon W	356.000
Z	-2.404
Asymp. Sig (2-tailed)	.016

Sources: Research 2025

The execution of the Mann-Whitney U Test in **Table 6** yielded an Asymptotic Significance (two-tailed) value of 0.016, which resides below the established critical value of 0.05. This statistical outcome substantiates the presence of a significant divergence in pre-test performance between the cohorts subjected to experimental and control conditions.

To further elucidate the pedagogical implications of the Discovery Learning paradigm on learners' conceptual understanding of Mathematics, an inferential analysis was conducted using the Wilcoxon Signed-Rank Test. This non-parametric procedure, deemed appropriate due to the paired structure of the data, was conducted under a conventional alpha level of 0.05. Within this framework, a p-value falling below the threshold is interpreted as evidence of a statistically significant difference between the pre-and post-intervention scores. In contrast, a value surpassing the threshold is indicative of a lack of considerable variation.

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Table 7. Testing the Effect of the Discovery Learning Model on Understanding Mathematical Concepts

Test Statistics		
	Posttest_Control Pretest_Control	**Posttest_Experiment Pretest_ Experiment**
Z	-3.946	-3.981
Asymp Sig (2-tailed)	<.001	<.001

Sources: Research 2025

The outcomes derived from the Wilcoxon Signed-Rank Test in **Table 7** indicate that the Asymptotic Significance (2-tailed) values for both the control and experimental groups were found to be below the 0.05 threshold. Consequently, the null hypothesis (H0) is rejected in favor of the alternative hypothesis (Ha), thereby affirming that the implementation of the Discovery Learning model has a statistically significant effect in enhancing the conceptual understanding of Mathematics among fourth-grade students.

Based on the results of data analysis on hypothesis testing regarding the effectiveness of the Discovery Learning model on the ability to understand mathematical concepts of class IV students, it was found that there was a significant increase in this ability. Based on the data in **Table 2**, statistical analysis shows that the average score of students who participated in learning using the Discovery Learning model increased from 20.47% in the pretest to 52.33% in the posttest. In comparison, students who participated in learning with the expository model also experienced an increase, from 13.80% in the pretest to 35.90% in the posttest. Thus, although both models showed an increase, the Discovery Learning model recorded a higher growth, namely 31.86% obtained from the difference between the posttest and pretest scores, compared to the expository model which was only 22.1%.

Discussion

This study revealed a significant improvement in students' conceptual understanding of Mathematics following the implementation of the Discovery Learning model. The increase is likely attributed to the model's capacity to provide students with opportunities to explore mathematical ideas and independently construct their understanding, rather than passively receiving information through conventional, teacher-centred methods. The Discovery Learning model integrates key stages: stimulation, problem identification, data collection, data processing, verification, and conclusion which collectively foster an active learning environment (Khasinah, 2021). During the learning process, students were encouraged to observe patterns, formulate hypotheses, and draw logical conclusions through tasks related to number patterns and sequences, which are inherently abstract and demand higher-order thinking skills. Discovery Learning enables learners to comprehend abstract mathematical concepts through direct engagement with meaningful and real-world contexts (Trianingsih et al., 2019).

Each stage of the Discovery Learning model plays a distinctive role in promoting students' conceptual understanding. The first phase, stimulation, is critical in triggering curiosity and motivation. Students are exposed to concrete or abstract stimuli relevant to the topic, which encourages them to restate concepts, identify mathematical operations, and differentiate between examples and non-examples (Maslukah & Rosy, 2020). This is followed by the problem identification phase, where learners observe, define problems, and formulate hypotheses based on the given phenomenon. At this stage, students develop inquiry skills and strengthen their logical thinking and ability to reason systematically (Kusumaningrum & Hardjono, 2019).

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The third stage, data collection, allows learners to gather information from various sources such as reading materials, observations, or simple experiments. This process cultivates the skill of actively seeking, organizing, and interpreting data to deepen mathematical understanding (Sunarto & Amalia, 2022). In the data processing stage, students analyze and synthesize the information collected to identify relationships and patterns. They begin to construct preliminary conclusions, which reinforces logical reasoning and conceptual application (Maulina et al., 2018). The verification stage is used to test hypotheses through logical argumentation and data analysis. This enhances critical thinking and decision-making skills (Sya'adah & Samsudin, 2022; Indah, 2024). Finally, in the conclusion phase, students make generalizations and connect newly learned concepts with existing knowledge, which leads to meaningful learning.

Among these stages, data processing emerges as the most pivotal. This phase serves as the point where students actively construct and internalize mathematical concepts. Their understanding is then validated during the verification stage, further reinforcing the learning outcomes. The results of this study confirm that the Discovery Learning model significantly enhances students' comprehension of mathematical concepts, particularly in abstract topics such as number patterns. These findings are consistent with those previous research which demonstrate the model's effectiveness in supporting conceptual understanding (Annisa et al., 2023; Hanipah & Kania, 2023; Indah, 2024; Rahmadani et al., 2023).

The results of this study are also supported by previous research, which concluded that guided discovery learning produces better learning outcomes compared to direct instruction or unguided discovery (Rahmadani et al., 2023). The structured nature of Discovery Learning—through stages such as stimulation, problem identification, data collection, and conclusion—provides learners with a scaffolded process to develop strong conceptual frameworks. This supports Bruner's theory that learners construct new knowledge based on existing cognitive structures when given the opportunity to explore and make meaning independently (Mishra, 2023). Additionally, the findings reinforce Mayer's assertion that discovery learning is most effective when accompanied by proper scaffolding and teacher guidance (Hülsmann et al., 2024).

The application of the Discovery Learning model is in line with the principles of the Kurikulum Merdeka, which promotes learner autonomy, contextual learning, and differentiated instruction. By enabling students to build knowledge independently, the model supports diverse learning styles and readiness levels, making it highly relevant in contemporary educational settings. Despite these positive outcomes, this study has several limitations. The relatively small sample size (n = 42) may limit the generalizability of the results. Furthermore, the intervention focused on a single mathematical topic and was conducted over a short period. Future research should consider involving larger and more diverse samples, exploring a broader range of mathematical content, and incorporating digital tools or blended learning strategies within the Discovery Learning framework. Such integration could enhance student engagement, create dynamic learning environments, and support deeper conceptual understanding through the use of multimedia and interactive assessment tools.

CONCLUSION

The findings of this study indicate that the Discovery Learning model has a statistically significant positive effect on fourth-grade students' conceptual understanding of Mathematics. Compared to the expository method, students taught using Discovery Learning demonstrated greater gains in posttest performance, underscoring the model's effectiveness in fostering active engagement and deeper conceptual comprehension. Furthermore, this instructional approach is aligned with the student-centered and differentiated principles promoted by the Kurikulum Merdeka. Based on these findings, it is recommended that the Discovery Learning model be more widely implemented in elementary Mathematics instruction,

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particularly for abstract topics, to improve students' learning outcomes and support the development of higher-order thinking skills.

AUTHOR'S NOTE

The author declares that there is no conflict of interest regarding the publication of this article. The author confirms that the data and content of the article are free from plagiarism.

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