



The Effect of the Guided Discovery Learning Model on Fifth Grade Students' Understanding of the Water Cycle in the IPAS Subject

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Keywords

Guided Discovery Learning; Conceptual Understanding; Water Cycle

ABSTRACT

This study aimed to examine the effect of the Guided Discovery Learning model on fifth-grade students' conceptual understanding of the water cycle in the IPAS subject. The research employed a one-group pretest–posttest design involving elementary school students as research participants. Students' conceptual understanding was measured using a test instrument that had been validated through content validity and demonstrated acceptable reliability (Cronbach's Alpha = 0.706). Data analysis was conducted by first testing the normality of the difference scores (posttest–pretest) using the Shapiro–Wilk test, followed by a paired sample t-test to examine the effect of the intervention. The results showed a significant improvement in students' conceptual understanding of the water cycle after the implementation of Guided Discovery Learning ($p < 0.05$). These findings indicate that Guided Discovery Learning effectively supports meaningful learning by actively engaging students in exploration, scientific reasoning, and guided concept discovery. Therefore, this learning model is relevant for enhancing elementary students' conceptual understanding in science learning, particularly within the context of the Merdeka Curriculum.

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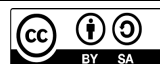
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INTRODUCTION

The implementation of the Merdeka Curriculum in elementary schools necessitates innovative and effective science learning models to enhance education quality and strengthen students' holistic understanding of fundamental concepts. Science is systematic knowledge about nature and the physical world, and it also refers to systematic knowledge obtained through observation, research, and experimentation that leads to the identification of the fundamental characteristics or principles of the phenomena being investigated or studied (Kemendikbud, 2020). The Merdeka

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Curriculum requires students to achieve the learning outcomes in science subjects as evidence of learning mastery. Students are expected not only to grasp the concepts but also to be able to implement them in the form of projects that solve real-world problems (Astuti, 2022). In every learning process, educator creativity plays a crucial role in selecting and applying appropriate learning models for science, thereby fostering student interest (Susanto, 2019). Therefore, selecting the right learning model within the Merdeka Curriculum is essential to provide significant, active, and student-centered learning experiences.

Observation results at SDN 3 Bulungan indicate that fifth-grade students face difficulties in comprehending Science (IPAS) subjects, particularly regarding abstract concepts such as the water cycle. The water cycle is the regular movement of water from the ocean to the air, then to the land, and flowing out to the sea (Hartono, 2017). A solid conceptual grasp of the water cycle is important because it influences their comprehension of other natural phenomena, such as water resources, climate, and weather (Safitri et al., 2024). Phenomena such as rainfall, evaporation, and condensation become more understandable for students when they possess a solid conceptual grasp of the water cycle. This cycle consists of three fundamental processes: evaporation, condensation, and precipitation (Sahin, 2020). Recent international studies emphasize that abstract water cycle related concepts are more effectively understood when students engage in structured experiential learning (Levy & Moore Mensah, 2020). This indicates that elementary school students develop a stronger conceptual understanding of the water cycle when learning is designed around firsthand experiences, such as observation, guided exploration, and reflection on water-related phenomena. These learning experiences allow students to actively construct meaning rather than passively receive information. This approach is consistent with the principles of Guided Discovery Learning, which encourages learners to uncover the connections between each stage of the water cycle through data interpretation, structured discussion, and purposeful observation.

A solid understanding of the water cycle enables students to comprehend various natural phenomena related to water (Nisa et al., 2023). and recognize the importance of maintaining ecosystem balance (Lady Alfie et al., 2023). However, students frequently encounter challenges in grasping Science concepts due to their limited understanding of

the instructional content shared by the teacher, coupled with the persistent use of conventional teaching methods, which discourages them from asking questions (Oktaviani et al., 2021). Based on the students' daily assessment scores, only 25.81% of students achieved scores exceeding the Learning Objective Achievement Criterion (KKTP), while 74.19% remained below the KKTP threshold. The lowest score obtained was 43, while the highest score reached only 82. Therefore, the implementation of an unsuitable learning model can significantly impact students' academic achievement.

The implementation of inappropriate teaching models can lead to a monotonous and unengaging classroom atmosphere, hindering students' optimal understanding of Science (IPAS) concepts (Manurung & Anazifa, 2024). This issue of low conceptual mastery in IPAS aligns with the findings of (Zumrotun et al., 2025), who identified a significant gap between the ideals of the Merdeka Curriculum and on-the-ground resources. Their study revealed that a majority of teachers expressed an urgent need for integrated, thematic, and contextual teaching materials, as the existing textbooks are still perceived as fragmented between science and social studies content. This situation underscores that IPAS learning must not be solely focused on content mastery but must emphasize the learning process to achieve its goals. To achieve these objectives, educators are required who can creatively design and implement innovative and efficient learning models. In such models, students actively inquire, explore, and utilize their thinking skills to discover concepts and solve problems (Santiani et al, 2024). Therefore, instructional models such as Guided Discovery Learning are relevant to be tested for their effectiveness in this context, particularly given findings that technological support and teacher training are key factors for successful curriculum implementation (Saa, 2024).

Guided Discovery Learning (GDL) is a model highly relevant to the philosophical principles of the Merdeka Curriculum, which emphasizes the learner's role in autonomously constructing knowledge. As a teaching strategy, GDL can be effectively implemented by educators in Science (IPAS) subjects to develop students' scientific processing skills and enhance learning achievement (Sulastri, 2023). Furthermore, GDL facilitates an intuitive process of comprehending meanings, concepts, and interrelationships to formulate conclusions (Hidayanti, 2023). Recent international studies emphasize that student-centered learning does not mean learning without

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guidance. De Jong et al., (2024) argues that approaches positioned between inquiry based learning and direct instruction such as guided discovery are more effective in supporting students' conceptual understanding. Without sufficient guidance, pure inquiry may lead to cognitive overload, particularly when students learn abstract scientific concepts. Therefore, guided discovery learning provides a balanced approach by combining learner autonomy with structured instructional support.

In contrast to traditional, teacher-centered models, Guided Discovery Learning encourages students to actively engage in exploring information, solving problems, and developing their understanding autonomously through direct experience (Salam & Kasmawati, 2023). Consequently, the knowledge acquired is retained in students' memory for a longer duration and is less easily forgotten. The GDL model features a structured syntax suitable for classroom implementation to strengthen scientific literacy and student academic achievement. This syntax includes steps such as identifying problems, gathering data, processing data, and drawing conclusions from real-world issues (Karimah & Sunarti, 2023). Heppt et al., (2023) further emphasize that structured instructional support is essential in inquiry-based science learning at the primary school level, especially for topics requiring deep conceptual understanding. Therefore, GDL was selected as the instructional model for this study.

Previous research has demonstrated that the implementation of the Guided Discovery Learning model significantly deepens students' conceptual understanding in Science (IPAS) learning. This approach emphasizes students' active role in independently discovering concepts and knowledge, thereby enabling them to resolve various encountered problems (Olivia & Sanoto, 2023a). Furthermore, students who actively participate in learning activities show improved proficiency in comprehending scientific concepts, as the Guided Discovery Learning model requires active engagement to achieve learning objectives (Nurbayanti et al., 2024).

This study focuses on examining the extent to which the application of the Guided Discovery Learning (GDL) model influences the conceptual understanding of Science among fifth-grade elementary school students, particularly regarding abstract topics such as the water cycle. This The learning model has demonstrated its effectiveness in increasing student motivation and participation while strengthening critical thinking skills

and comprehension of the water cycle concept (Akmalia Nada & Syahru Romadhon, 2024) Additionally, this research assesses the effectiveness of GDL compared to the conventional lecture-and-memorization approach that has been predominantly used. Significant differences were found in science learning outcomes between students who experienced GDL and those who underwent conventional instruction (Anggut et al., 2021). It is expected that this study will provide a practical foundation for educators to design interactive, discovery-based learning processes aligned with the principles of the Merdeka Curriculum that emphasize learning autonomy.

This study provides significant contributions to both theoretical and practical dimensions. Theoretically, it is expected to refine the learning process and deepen students' conceptual understanding of Science (Aningsih & Wolosah, 2020). Practically, the research fosters student autonomy and responsibility toward their own learning process, as students become more self-motivated when discovering knowledge independently. In implementing the Guided Discovery Learning model, educators serve as facilitators who provide a responsive learning environment tailored to student needs. Teachers offer students opportunities to experiment without fear of punitive consequences (Carin, 1989).

Despite the mandate of the Merdeka Curriculum to promote active, student-centered learning experiences, the implementation of IPAS learning in elementary schools still faces significant challenges. On the one hand, the curriculum requires students to actively construct knowledge and understand scientific processes through meaningful learning activities (Astuti, 2022). On the other hand, classroom observations indicate that students continue to struggle with abstract science concepts such as the water cycle, which are often taught using conventional, teacher centered approaches. This situation is further exacerbated by the limited availability of integrated and contextual IPAS teaching materials, as previous studies have reported a gap between curriculum expectations and the instructional resources available to teachers (Zumrotun et al., 2025). Therefore, this study aims to empirically test the effectiveness of the Guided Discovery Learning (GDL) model in improving fifth grade students' understanding of the water cycle in the IPAS subject. It is expected that this study will provide evidence-based

insights for elementary school teachers in selecting effective, student-centered instructional strategies that align with the principles of the Merdeka Curriculum.

METHOD

This study employed a quantitative approach with a pre-experimental research design using a single-group pretest-posttest model. This design was chosen to examine changes in students' conceptual understanding before and after the implementation of the Guided Discovery Learning (GDL) model in a single learning group. Prior to hypothesis testing, assumption testing was conducted to ensure the appropriateness of the statistical procedure. Because this study employed a one-group pretest–posttest design, the assumption of homogeneity of variance was not applicable. Normality testing was therefore conducted on the difference scores (posttest–pretest), as required for the paired samples t-test. The normality of the difference scores was examined using the Shapiro–Wilk test.

After the normality assumption was satisfied, hypothesis testing was carried out using a paired samples t-test to determine whether there was a significant difference in students' conceptual understanding of the water cycle before and after the implementation of the Guided Discovery Learning model. The research design is represented in Table 1 below:

Table 1. *Research Design*

$$O_1 \longrightarrow X \longrightarrow O_2$$

Description/Key:

- O1: Pretest score obtained before the implementation of the Guided Discovery Learning model.
- X : Treatment given, which was the implementation of the Guided Discovery Learning model.
- O2: Posttest score obtained after the implementation of the Guided Discovery Learning model.

The participants of this study comprised the entire fifth-grade class at SDN 03 Bulungan, totaling 32 students. Because all students in the accessible population were involved in the study, this research applied a census approach rather than sampling in the traditional sense. Therefore, no probability or non-probability sampling technique was employed. The use of a census approach indicates that the analysis focuses on examining changes in learning outcomes within this specific group, rather than generalizing findings to a broader population.

Data were collected using test and documentation techniques. The research instrument was a multiple-choice test designed to assess fifth-grade students' conceptual understanding of the water cycle. The instrument comprised 11 items developed in accordance with the learning objectives and indicators of conceptual understanding in the IPAS subject, encompassing evaporation, condensation, and precipitation processes (Imanah et al., 2022). Item development followed established principles of educational measurement, emphasizing alignment among indicators, content, and instructional objectives (Hutasuhut & Albina, 2025).

The instrument validity employed in this study was content validity, which was conducted to ensure that each test item adequately represented the intended construct of conceptual understanding (Sugiyono, 2020). Content validation was carried out through expert judgment involving two experts in elementary science education, who evaluated the instrument in terms of content relevance, clarity of item wording, and alignment with the learning indicators of the water cycle. The expert evaluations indicated that all items were consistent with the specified indicators and appropriate for measuring students' conceptual understanding (Yanti, 2022). Content validity is a critical stage in test development, particularly to ensure accurate measurement of abstract cognitive constructs (Azizah & Chalimatusadiah, 2025).

In addition to validity, the reliability of the instrument was examined to determine the internal consistency of the test items. Reliability analysis was conducted using Cronbach's Alpha coefficient, as the instrument consisted of multiple-choice items scored dichotomously. The results yielded a reliability coefficient of $\alpha = 0.706$ (Yusup, 2018). Which exceeds the minimum acceptable threshold of 0.70, indicating that the instrument demonstrates acceptable reliability and consistency in measuring students' conceptual understanding (Azizah & Chalimatusadiah, 2025). The results of the reliability analysis are presented in Table 2.

Table 2. *Instrument Reliability Analysis*

| Scale Reliability Statistics | |
|------------------------------|---------------------|
| | Cronbach's α |
| scale | 0.706 |

Operationally, conceptual understanding of the water cycle in this study is defined as students' ability to explain, identify, and relate the core concepts of the water cycle, including the definition of each process, the sequence of the cycle, and the cause-and-effect relationships among evaporation, condensation, and precipitation. The indicators of conceptual understanding include: (1) the ability to recognize and explain the basic concepts of the water cycle, (2) the ability to identify the processes involved in the water cycle, and (3) the ability to apply water cycle concepts to simple natural phenomena. Assessment was conducted by scoring students' responses, with each correct answer assigned a score of 1 and each incorrect answer a score of 0. The total score reflects the level of students' conceptual understanding, with higher scores indicating better understanding. The same instrument was administered for both the pretest and posttest to ensure measurement consistency and to allow accurate comparison of students' learning outcomes before and after the implementation of the Guided Discovery Learning model.

RESULT AND DISCUSSION

Results

This study examined changes in fifth-grade students' understanding of the water cycle in the IPAS subject before and after the implementation of the Guided Discovery Learning (GDL) model. Students' conceptual understanding was measured using a validated instrument consisting of 11 multiple-choice questions administered as a pretest and posttest. The results of the Shapiro–Wilk normality test conducted on the difference scores indicated a significance value greater than 0.05, suggesting that the data were normally distributed. Therefore, the assumption of normality for the paired samples t-test was met, allowing further hypothesis testing to be conducted.

Figure 1. Normality Test

| | Kolmogorov-Smirnov ^a | | | Shapiro-Wilk | | |
|---------|---------------------------------|----|------|--------------|----|------|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Selisih | .150 | 32 | .066 | .965 | 32 | .366 |

a. Lilliefors Significance Correction

Based on the normality test conducted on the difference scores (posttest–pretest), the Shapiro–Wilk test yielded a significance value of 0.366, which is greater than the significance level of 0.05. This result indicates that the difference scores are normally

distributed; therefore, the normality assumption required for the paired-samples t-test has been satisfied. With this assumption fulfilled, the paired-samples t-test is considered appropriate and valid for examining differences in students' conceptual understanding before and after the implementation of the instructional model under investigation.

Studies on the implementation of the Guided Discovery Learning model indicate that normality testing is a crucial step to ensure that learning outcome data meet the required statistical assumptions prior to analysis using t-tests. One study emphasized that satisfying the normality assumption serves as the foundation for the use of parametric statistical analysis in examining the effect of Guided Discovery Learning on elementary school students' critical thinking skills (Dewi et al., 2021). Furthermore, a bibliometric review conducted by another group of researchers revealed that studies related to Guided Discovery Learning in the field of education generally apply prerequisite tests, including normality testing, before conducting inferential analysis. This finding reinforces that fulfilling the normality assumption is an essential procedure in quantitative educational research employing parametric analysis (Ramadhaniyati et al., 2023).

Figure 2. Paired Sample T-Test Results

| | | Paired Differences | | | | |
|--------|--------------------|--------------------|----------------|-----------------|---|---------|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Pair 1 | Pretest - Posttest | -22.625 | 18.213 | 3.220 | -29.192 | -16.058 |

| t | df | Sig. (2-tailed) |
|--------|----|-----------------|
| -7.027 | 31 | <.001 |

The results of the paired-samples t-test indicated a mean difference between the pretest and posttest scores of -22.625 , suggesting that the posttest scores were higher than the pretest scores. The obtained t value was -7.027 with 31 degrees of freedom ($df = 31$), and the significance value (Sig. [2-tailed]) was $0.000 (<0.05)$. These findings demonstrate a statistically significant difference between students' pretest and posttest scores following the implementation of the instructional model. Therefore, it can be concluded

that the applied learning model had a significant effect on improving students' conceptual understanding.

The use of the paired-samples t-test in quantitative educational research aims to examine differences in students' learning outcomes before and after an intervention is administered to the same group (Saputra et al., 2022). A study conducted by Rini et al., (2021) on the effectiveness of the Guided Discovery Learning model in improving students' critical thinking skills employed a paired-samples t-test to analyze differences between pretest and posttest scores. The analysis was performed after first confirming that the required statistical assumptions had been satisfied. The results revealed a significant difference between scores before and after the implementation of the instructional model, indicating that Guided Discovery Learning had a positive effect on enhancing students' critical thinking skills. Therefore, the paired-samples t-test is an appropriate analytical technique for one-group pretest–posttest research designs in measuring the effect of an instructional model on improvements in students' learning outcomes (Rini et al., 2021).

Discussion

The findings of this study indicate an improvement in students' understanding of the water cycle concept following the implementation of the Guided Discovery Learning model. Pedagogically, this improvement can be explained by the characteristics of the model, which position students as active agents in the process of concept discovery (Ubaidah & Aminudin, 2018). Through stages of observation, exploration, data collection, and conclusion drawing, students are trained to construct knowledge meaningfully based on direct learning experiences. As a result, the water cycle concept is not merely memorized but understood as an interconnected natural process (Samudera et al., 2022).

The implementation of Guided Discovery Learning enhances students' conceptual understanding of the water cycle by engaging them as active learners who are directly involved in the process of discovering concepts. In science instruction, the water cycle is inherently process-oriented and requires an understanding of cause-and-effect relationships among natural phenomena (Sihombing et al., 2025). Through systematic

instructional stages, students are guided to observe phenomena, identify problems, and draw conclusions based on independently conducted exploration (Supriani et al., 2025). This structured discovery process supports the meaningful and sustained construction of conceptual understanding.

From a cognitive perspective, Guided Discovery Learning encourages the development of scientific and logical thinking skills through investigative activities. Students are not merely recipients of information; rather, they are trained to analyze data, connect concepts, and construct understanding based on their learning experiences (Ayu et al., 2025). This process contributes to the formation of stronger cognitive structures, resulting in deeper and more enduring conceptual understanding (Simamora et al., 2018). Discovery based learning has also been shown to enhance the quality of students' reasoning in understanding complex science concepts (De Jong et al., 2024). Fundamentally, students' conceptual understanding improves when learning is structured to actively engage learners in meaning-making rather than passive information reception (Dafira & Widodo, 2021).

Exploratory activities in Guided Discovery Learning play a crucial role in helping students develop a concrete understanding of the water cycle concept. Through direct observation, simulations, or simple experiments, students are able to relate natural phenomena to the scientific concepts being studied. Active engagement in exploration enables students to understand evaporation, condensation, and precipitation in a contextualized manner, rather than merely memorizing definitions (Levy & Moore Mensah, 2020). Such experiential learning has been proven effective in improving elementary school students' conceptual understanding of science (Heppt et al., 2023).

The success of model implementation depends on teachers' ability to design learning environments that balance student autonomy with appropriate instructional support (Saa, 2024). In Guided Discovery Learning, the teacher's role is essential as a facilitator who provides guidance throughout the learning process. Teachers offer direction, guiding questions, and clarification to help students remain on the correct conceptual pathway without diminishing their learning independence (Fitriani et al., 2023). This guidance functions as scaffolding that supports students in gradually

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constructing conceptual understanding (Muhali et al., 2021), thereby helping to prevent misconceptions related to the water cycle.

In addition to enhancing conceptual understanding, Guided Discovery Learning also contributes to increased student motivation and learning engagement. Active involvement in the discovery process fosters a sense of ownership in learning, which enhances students' confidence and interest. This interactive and participatory learning environment has a positive impact on students' science learning outcomes (Olivia & Sanoto, 2023). Meaningful and challenging learning experiences further encourage students to ask questions and engage in discussions during the learning process (Sasingan & Wote, 2022).

Guided Discovery Learning is an effective instructional model for enhancing students' understanding of the water cycle concept, as it integrates scientific thinking processes, exploratory activities, and proportional teacher guidance (Aldiyansyah et al., 2024). This model enables students to construct knowledge independently while remaining guided, resulting in deeper and more applicable conceptual understanding. The guided discovery-based learning approach is therefore considered relevant for implementation in elementary science education to improve the quality of students' conceptual understanding (Arbain & Shukor, 2015).

Within the context of the Merdeka Curriculum, Guided Discovery Learning aligns with the curriculum's emphasis on student-centered learning and the development of higher-order thinking skills (PS & Yerizon, 2025). This curriculum promotes learning experiences that allow students to actively construct knowledge through inquiry, reflection, and real-world problem solving (Silalahi, 2024). Guided Discovery Learning supports these principles by positioning students as active learners, while teachers act as facilitators who provide structured guidance to ensure that the discovery process remains focused and meaningful (Pattimukay et al., 2025).

The Merdeka Curriculum also emphasizes the strengthening of Higher Order Thinking Skills (HOTS), learner autonomy, and contextual learning that is relevant to students' lives. Guided Discovery Learning has been shown to effectively support these goals by encouraging students to analyze, interpret, and draw conclusions through systematic exploration processes (Nuranisa et al., 2025). Studies have demonstrated that

the implementation of Guided Discovery Learning within the Merdeka Curriculum framework enhances students' critical thinking skills, learning outcomes, and HOTS across various subjects, including Islamic Religious Education and Character Education, IPAS, and mathematics (Arafah & Muliati, 2025).

Thus, the successful implementation of this model is highly dependent on teachers' ability to design adaptive learning environments that balance student autonomy with appropriate scaffolding, as emphasized in the Merdeka Curriculum (PS & Yerizon, 2025). Discovery Learning functions not only as an instructional strategy but also as a pedagogical innovation that supports the transformation of learning toward more meaningful, reflective, and competency-oriented education aligned with 21st-century skills development (Banila et al., 2023).

CONCLUSION

This study concludes that the Guided Discovery Learning (GDL) model effectively improves fifth grade students' understanding of water cycle concepts in the IPAS subject. Through structured guidance and active exploration, GDL enables students to construct scientific concepts more meaningfully by connecting observable phenomena with underlying processes such as evaporation, condensation, and precipitation. The increase in students' learning outcomes, as reflected in the average posttest score of 60.00 out of a maximum score of 100, indicates that guided discovery supports conceptual development more effectively than conventional teacher centered instruction within the observed classroom context. These findings highlight the pedagogical value of Guided Discovery Learning as an instructional approach that aligns with the principles of active, student centered learning emphasized in the Merdeka Curriculum.

Despite the positive impact of the Guided Discovery Learning model on students' conceptual understanding, this study has several limitations that should be acknowledged. The use of a pre-experimental one-group pretest–posttest design without a control group limits the strength of causal inference, as improvements in learning outcomes may have been influenced by factors such as maturation, testing effects, or prior exposure to the content. Methodological studies in educational research emphasize that such designs are exploratory in nature and should be interpreted with caution when attributing effects

solely to an instructional intervention (Heppt et al., 2023). In addition, the study was conducted with a single class in a specific school context, which restricts the generalizability of the findings to broader populations or different instructional settings. Previous research highlights that replication across diverse contexts and the inclusion of comparison groups are necessary to strengthen external validity and provide more robust evidence of instructional effectiveness (Fadzli Jusoh et al., 2024).

Based on the findings of this study, it is recommended that elementary school teachers consider implementing the Guided Discovery Learning model as an alternative instructional strategy for teaching abstract science topics, particularly within IPAS learning. Teachers are encouraged to design learning activities that combine guided inquiry with concrete examples and contextual phenomena to support students' conceptual understanding. Future research is recommended to employ experimental or quasi experimental designs with control groups and larger samples to further examine the effectiveness of Guided Discovery Learning across different contexts and science topics.

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