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Do Students Understand the Concept of Science? Diagnostic Studies of Comprehension in Elementary School

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ABSTRACT

Science learning in elementary schools plays a crucial role in building students' scientific thinking skills and science literacy from an early age. However, reality shows that students' understanding of science concepts in Indonesia is still low, as reflected in the consistent decline in PISA scores from 2015 to 2022. This study aims to objectively describe the conditions of understanding science concepts of grade IV students in three elementary schools in the Caturtunggal cluster, Sleman. Using a descriptive quantitative approach, data were collected through observation, interviews, and document analysis of 107 students. The results showed that 87% of students had scores below the Minimum Completeness Criteria (KKM), with an average score of only 52.16. Factors indicated related to students' understanding of concepts include the lack of direct scientific learning experience during the COVID-19 pandemic transition period and the limited availability of learning media that are adaptive to their needs. Based on these findings, this study emphasizes the urgency of developing instructional media innovations, especially Student Worksheets (LKPD) which are designed adaptively and relevant to improve mastery of science concepts optimally.

Keywords: Concept Understanding; Science; Diagnostic Studies

INTRODUCTION

Science learning in elementary school is essential for building scientific and critical thinking in students from an early age (Yang et al., 2020). The ability to think scientifically at this level begins to be systematically instilled through a significant learning process. This is very important because rapid advances in technology and science require human resources who are able to think scientifically (Mahrunnisya, 2023). Science is a fundamental skill that helps humans understand natural phenomena and solve problems (Gizaw & Sota, 2023), science goes beyond just studying material or memorizing scientific concepts (Assem et al., 2023). Students who have scientific literacy are able to make evidence-based decisions in their daily lives (Purnawati & Yakin, 2025). Therefore, the goal of teaching science in elementary school is to equip students with the necessary skills to objectively assess scientific data and provide scientific explanations for the phenomenon (Winarni et al., 2020). Students are expected to be able to critically overcome various scientific and technological challenges that are still developing in society by mastering these abilities (Haratua et al., 2025).

A fundamental component of scientific literacy is conceptual understanding, which includes all aspects of competence, knowledge, context, and attitudes towards science (Saraswati et al., 2021). The ability to use scientific knowledge to analyze scientific data, explain natural events, and critically address new social challenges is part of scientific literacy, which goes beyond simply learning scientific principles through texts (Febriana et al., 2021). The level of a student's ability to use the scientific ideas they have learned to solve various problems and make evidence-based assessments in daily life determines how well they have learned science (Purnawati & Yakin, 2025).

A strong understanding of these concepts from the early years of elementary school is essential, as these concepts form the basis of students' scientific thinking (Umardianti et al., 2023; Yuliandari & Anggraini, 2021). Students learn to observe, predict, and draw conclusions based on scientific data through relevant science education in elementary school (Oviana & Hayatillah, 2025). The quality and clarity of students' scientific

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thinking skills as they progress to more difficult levels of education will be greatly influenced by the foundations built during the elementary school level.

Based on global data from the Program for International Student Assessment (PISA) framework (PISA), the current state of science literacy in Indonesia reveals a reality that requires significant attention. Indonesia experienced a decline in scores in the field of science. According to the results of PISA 2015, Indonesia received an average score of 403 in the field of science, while the OECD average in the field of science was 493 (OECD, 2016). The next PISA results in 2018 found that the average Indonesian science field was 396, while the OECD average in science was 489 (OECD, 2019). The average score of Indonesian science in 2022 was 383 with an average score of 485 (OECD, 2023). The results of PISA data interpret that Indonesia's science score has decreased from 2015 to 2022 and the scores in the three periods have not reached the OECD average. This decrease in score indicates that the students' understanding of science concepts in Indonesia is getting lower. The same thing was found from the results of the research of (Deliany et al., 2019) namely the low understanding of students' concepts in science subjects. This decline in grades is a clear sign that students' understanding and application of scientific concepts in various real-world situations has not reached their full potential.

Theoretically and empirically, the science literacy score in the PISA data for 2015 – 2022 is an cumulative impact of the quality of the foundation of concept understanding built since elementary education. Grade IV of elementary school is a crucial transition phase where students begin to be exposed to more abstract and complex science concepts. When misconceptions and obstacles to understanding concepts in Class IV are not diagnosed and addressed early, the deficit in understanding will be carried over to higher levels of education. Therefore, the decline in PISA scores serves as a macro justification regarding the urgent need for diagnostic studies at the elementary school level to identify the root of the science literacy problem from its foundation.

Problems in classroom learning are reflected in the gap between curriculum expectations and actual conditions. In the field, science education is usually quite theoretical and focuses on memorization (Siregar et al., 2025). As a result, students miss out on the opportunity to gain real-world scientific experience, which should have been gained through research and practical demonstrations (Rohma et al., 2026). Students fail to connect academic ideas to real-world happenings without contextual scientific experience, which leads to poorly developed conceptual understanding (Asmayani et al., 2024).

Grade IV elementary school students are introduced to more complex and abstract scientific concepts than in previous classes as an important milestone in their academic development. At this stage, relevant learning begins to build a solid foundation for scientific thinking skills. However, in practice, this challenge is often encountered by students' inability to analyze content and provide scientific explanations for various natural phenomena (Zulkarnain & Nurjanah, 2022). This situation shows a lack of understanding of science concepts in scientific situations (Savitri & Meilana, 2022).

Students are more likely to experience prolonged misunderstandings if the learning process is not accompanied by a thorough understanding of concepts (Laira Hrp et al., 2025). This usually happens because science training in elementary school focuses more on theory and memorization than offering real-world scientific experiences (Siregar et al., 2025). Learning can lose its meaning if prospective teachers or educators are unable to overcome these challenges, which will ultimately adversely affect students' future enthusiasm for learning science. As a result, the problem of learning science in grade IV of elementary school requires extra attention to strengthen students' conceptual comprehension skills from an early age.

Previous studies have examined the low understanding of science concepts, but tend to focus on final learning outcomes without diagnostically mapping the specific location of students' cognitive indicator barriers. Therefore, a comprehensive diagnostic picture is needed with a preliminary study on the empirical assessment of conceptual understanding of fourth grade students at SDN Caturtunggal 3, SDN Caturtunggal 4, and SDN Babarsari. This study focuses on the initial identification of learning barriers, especially the understanding of science concepts experienced by students as an effort to make a real contribution to improving the quality of science education in elementary schools. The selection of the three schools is based on the goal of obtaining a comprehensive diagnostic picture and avoiding bias if only researching one single school. Thus, the results of this study can be used as a database to design future studies.

METHOD

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This study is a preliminary study that uses a quantitative approach with a descriptive method. The purpose of this design is to objectively describe the real conditions of understanding science concepts of students at the grade IV level of elementary school. The research was carried out in three elementary schools in the Caturtunggal cluster, namely SDN Caturtunggal 3, SDN Caturtunggal 4, and SDN Babarsari in Sleman district, Yogyakarta from August to September 2023. The research subjects consisted of 107 grade IV students in the odd semester of the 2023/2024 school year. The selection of subjects was carried out using purposive sampling techniques with the consideration that class IV is a crucial transition phase where science material begins to involve more complex and abstract concepts.

The procedure used in this study was carried out by examining data obtained from various sources. This study uses a descriptive quantitative approach to objectively describe the profile of students' science concept understanding. The main data was obtained through a concept understanding test which was analyzed using descriptive statistical techniques. The concept understanding test was in the form of a 10-item description test on the substance form and its changes. The instrument was developed based on the cognitive dimension of understanding (C2) of the revised bloom taxonomy (Anderson et al., 2001) which includes indicators: interpreting, giving examples, classifying, comparing, and explaining. The instrument was validated by a content validity test by an expert lecturer to assess the alignment of indicators, the suitability of material substransit, and language readability. Students' answers were assessed using an analytical scoring rubric (score 0–4) which was converted to a scale of 0–100 (Purwanto, 2013). Learning completeness refers to the KKM set by the school (≥75), with five categories of mastery level achievement adapted from (Arikunto, 2015): Very High (81–100), High (61–80), Medium (41–60), Poor (21–40), and Very Poor (0–20).

This study is also equipped with qualitative data as a supporting through semi-structured interviews and classroom observations to strengthen and confirm quantitative data. Qualitative data are analyzed using a model (Miles et al., 2014), namely data reduction, data display, and conclusion drawing/verification.

RESULTS AND DISCUSSION

Based on the results of semi-structured observations, semi-structured interviews, and document analysis that have been carried out at SDN Caturtunggal 3, SDN Caturtunggal 4, and SDN Babarsari in Sleman district from August to September 2023, several results were found related to students' understanding of concepts in science learning. The data from the test results of the concept understanding test for grade IV students was processed in a descriptive statistical manner to find out the general picture of the mastery of the material. Based on the results of the analysis of the science concept understanding test results, the frequency distribution data presented in table 1 was obtained (Arikunto, 2015).

Table 1. Frequency Distribution of Students' Understanding of Science Concepts

Score Range	Category	Frequency	Percentage
81 - 100	Very High	8	7%
61 – 80	High	26	24%
41 – 60	Medium	40	37%
21 – 40	Less	30	28%
0 – 20	Very Less	3	3%

Table 1 visualizes the results of the distribution of students' understanding of science concepts in the "Very High" category by 7%, the "High" category by 24%, the "Medium" category by 37%, the "Less" category by 28%, and the "Very Less" category by 3%. The average score of the students' overall science concept understanding score was 52.16 which shows that in general the understanding of science concepts in class IV has not reached the expected completeness criteria. The results of observations to schools obtained information that the minimum completeness criteria that students must achieve to pass the subject is 75. The results of the percentage of completeness of understanding science concepts for grade IV students are presented in table 2.

Table 2. Data Analysis of Science Concept Understanding Results

School	Value < 75	Percentage (%)	Value ≥ 75	Percentage (%)
SDN Caturtunggal 3	26	93	2	7
SDN Caturtunggal 4	49	96	2	4
SDN Babarsari	18	64	10	36

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Table 2 presents the results of the analysis of the science concept understanding test for grade IV students based on the minimum completeness criterion score, namely most of the students in the three schools are below the KKM limit, namely 26 students or 93% at SDN Caturtunggal 3, 49 students or 96% at SDN Caturtunggal 4, and 18 students or 64% at SDN Babarsari. The average percentage of scores below the overall KKM is 93 students or 87% which shows that in general the understanding of science concepts of grade IV students is still in a low position and needs to be analyzed through interviews and further observations. The results of interviews with science teachers in elementary schools are presented in table 3.

Table 3. Interview Results of Grade IV Teachers

No	Questions	Responden I	Responden II	Responden III
1	What is the ability to understand the concept of science for grade IV elementary school students?	Students' understanding of concepts is still lacking.	The understanding of the concept of students here is still low, ma'am.	The understanding of the concept of students here is still lacking, ma'am.
2	Is there any data or events that prove the problem?	Judging from the students who are still confused when asked about the material that has been taught before, even the material that was only yesterday was delivered.	Judging from the learning outcomes of IPAS students, which tends to be low, which is less than 75.	Usually the children answer questions, both verbal and written, that are not appropriate and relevant to the questions given. They also have difficulty giving examples of material concepts in their real lives.
3	What causes a learner's concept comprehension skills to be low?	The impact of the learning transition during covid.	The transition from the covid period, so children are too complacent with the learning process at home, so that when the learning process returns to normal, students find it difficult to adjust which ultimately has an impact on their low understanding of concepts.	It seems that they have little or no experience relevant to certain concepts, because a few years ago it was during covid which affected the learning process. It is possible that this can affect students' experience of the material.
4	According to you, is it important to learn concept comprehension skills in students from elementary school age?	It is very important that understanding concepts become the basis for students to learn the next material.	Very important.	It is very important, because it is their capital to learn the next material.
5	What are the obstacles that you experience when trying to learn concept understanding in students with this strategy?	Time constraints to integrate interesting learning strategies into certain learning support devices.	I'm still learning it, ma'am. But it is still gradual, because it is constrained by limited time. Because we teachers are now obliged to teach and fulfill various administrations, so it takes extra time to learn them.	I have tried to work on several subjects, but it has not been fulfilled for all discussions, because this is a new curriculum and the composition of the material is also new, so it is still gradual to work on it, because we have limited time and knowledge to develop it.

Table 3 explains that students' ability to understand science concepts is still low, as evidenced by teachers' observations while teaching and assessment data. This is due to the little or even no direct learning experience experienced by students during the distance learning period during the previous covid period. The three teacher respondents agreed that it is very important for students to have the ability to understand this concept from elementary school age. However, the three respondents were constrained by limited time to develop and prepare learning innovations to overcome this. In order to validate the data, the researcher also made observations during science learning in the classroom, the results of which are presented in table 4.

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Table 4. Results of Science Learning Observation in the Classroom

No	Statement	Yes	No	Remarks
1	Students are able to interpret the material		✓	Only 1-2 students can interpret the content of the substance material from the video
2	Students are able to provide examples of the content of the material		✓	Only 1-2 students can identify examples of substance forms
3	Students are able to classify objects according to certain properties		✓	No student can classify the characteristics of the substance
4	Students are able to compare related to the content of the material		✓	Students have difficulty comparing the characteristics of substance forms with each other
5	Students are able to explain the content of the material		✓	Only 1-2 students can explain the content of the material about the form of substances

The results of data analysis in this study explain that the ability to understand science concepts of grade IV students is still low. This is based on the results of document analysis, namely as many as 37% of students are in the "Medium" category and as many as 31% are in the "Less" and "Very Less" categories. Judging from the limit of the overall minimum completeness criteria, as many as 84.3% of students are below the KKM limit. This analysis is supported by the results of interviews with 3 teacher respondents who explained that the understanding of science concepts for grade IV students is still low. This statement is clarified by the respondent's answer which explains that many students are still wrong when invited to discuss the material that has been taught before. Learners' responses are often inappropriate and relevant to the questions given and they struggle to convey examples of material concepts in their real lives.

The findings regarding the low understanding of science concepts are in line with the results of research conducted by (Alamsyah et al., 2021), namely the low understanding of students' concepts in science subjects which is detected when students are less motivated to learn physics material in class. Low conceptual understanding was also identified in (Mudana, 2023) research which explained that there is a decrease in focus and boredom in the classroom which has a direct impact on students' low ability to connect material with real phenomena, as well as trap their mindset at the limit of textual memorization without authentic scientific experience. The low understanding of science concepts in students is closely related to the fact that motivation to learn science is still in the low category, both among prospective elementary school teachers and students (Putra et al., 2021).

The low understanding of science concepts in students is indicated by the summarized indicators that can be seen from the results of the students' answers, that students are not appropriate in Compiling work steps to make animal skeletons according to the material taught (Susanti et al., 2021). It was found that some students were not able to explain the material that had been studied, were unable to provide other examples of the material studied, and were not able to classify and conclude the material that had been studied in their own sentences (Nahdi et al., 2018). The lack of active involvement and lack of enthusiasm of students in the learning process indicate the difficulty of students in understanding the material explained by the teacher (Nasriyanti et al., 2021). Students stated that it was difficult to apply science materials in daily life because students tend to be passive and rely a lot on teachers as the only source of learning, which has an impact on students' lack of understanding of science concepts (Aningsih & Wolosah, 2020).

The condition of students' understanding of science concepts is contradictory to the ideal conditions of understanding the concept that should be. Understanding the concept of science is very important in the learning process to help the success of achieving maximum learning goals (Dewi & Primayana, 2019). Mastery of qualified science concepts plays a crucial role because it allows students to manage abstract and complex materials more effectively for the sake of optimizing the application of science (Janah & Hidayati, 2025). In-depth mastery of concepts is a vital aspect for students in line with the main goal of science education because it reflects the ability of students to internalize the meaning and essence of each scientific idea learned (Pratiwi, 2022). As a level of learning outcomes that go beyond the level of basic knowledge, understanding concepts is a crucial prerequisite for students in mastering the subject matter as a whole, especially in science subjects which make it the main foundation for achieving maximum learning outcomes (Aen & Kuswendi, 2020). The gap between ideal conditions and reality explains that there is a gap in problems related to students' understanding

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of science concepts. One of the efforts to mitigate these problems requires an in-depth analysis of factors that are indicated to contribute to improving students' competence in understanding science concepts.

Interview data highlights teachers' perceptions which indicate that the limited application of adaptive learning strategies and lack of direct scientific experience after COVID-19 are potential factors that contribute to the low understanding of science concepts in students. A similar thing was found in a study (Ridwan et al., 2023) which explained that post-pandemic brought major changes to the education system. In addition, teachers experience obstacles such as time management, extra administrative tasks, and a large amount of material coverage for one major learning title, which has an impact on students who are not able to master the material concepts to the maximum. The researcher also observed that during the learning process in the classroom, only a small percentage of students were able to interpret, identify examples, and explain the content of material in the form of substance. It was also observed that no students were able to classify the characteristics of the form of substances and students who had difficulty when invited to discuss to compare the characteristics of the form of the substance. Respondents also emphasized that the absence of representative learning media in meeting the needs of students is a strong indication of the cause of their suboptimal ability to understand science concepts. This finding is in line with a preliminary study by (Umardianti et al., 2025) which emphasized that the lack of adaptive learning media innovation is the main obstacle in science learning for grade IV elementary school students.

These diagnostic findings confirm the need to address the gaps identified in the conceptual understanding of science of elementary school students. Although qualitative indications from interviews and classroom observations suggest a potential association between low mastery of concepts, limited hands-on science practice experience, and lack of adaptive learning media, these factors are contextual indications and not definitive cause-and-effect relationships. To address these basic diagnostic barriers, the literature highlights several promising learning interventions, including technology-based devices (e.g., PhET, AR, and educational game simulations) as well as active learning models such as PBL and flipped classrooms (Banda & Nzabahimana, 2021; Byusa et al., 2022; Fitriyani & Rosnawati, 2026; Savitri & Meilana, 2022; Uno, 2024). More specifically, structured Learner Worksheets (LKPDs), especially those that integrate inquiry, STEM, or experimental approaches that offer practical ways to provide scaffolding of scientific thinking (Aisyah et al., 2024; Hanifah et al., 2023; Maulani et al., 2022; Umardianti & Aji, 2026). Therefore, the main implication of this diagnostic study is that there is an empirical basis for developing adaptive and contextually relevant LKPDs, tailored to the specific learning needs of elementary school students.

CONCLUSION

The ability to understand science concepts of elementary school grade IV students in general is still in the low category. This is shown by the overall average score of students which only reached 52.16, where the achievement did not meet the expected completeness criteria. Statistically, as many as 84.3% of students overall are still below the KKM limit, with the largest distribution of performance in the "Medium" category (37%) and the "Less" and "Very Less" (31%) categories.

Interview and observation data show that the low level of conceptual understanding may be related to the limited science learning involving hands-on practice during the post-pandemic transition period. In addition, challenges felt by teachers, such as the lack of adaptive learning media, time constraints, wide curriculum coverage, and administrative burdens are identified as contextual factors that can further hinder the optimization of science learning in the classroom.

The gap between ideal conditions and reality on the ground underscores the urgency of taking in-depth mitigation measures. As a logical implication, further research is needed that focuses on the development of learning guideline media innovations, especially worksheet-shaped devices (LKPD) that are designed in an adaptive, interactive, and relevant manner to the characteristics of students' needs in order to boost optimal mastery of science concepts.

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