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Elementary Students' Conceptual Understanding Ability in Science: Insights and Implications

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One important aspect in science learning in elementary school is students' ability to understand science concepts. Science learning in elementary school aims to improve students' positive attitudes in solving problems in the community through observation, question and answer activities, and data analysis. This study aims to describe elementary students' understanding of science concepts through targeted assessment aligned with key indicators of conceptual understanding in science. This study used quantitative approach with a survey method, the data in this study were taken from the distribution of tests to respondents. Data was collected through concept understanding tests to gain a view of elementary school students' conceptual understanding in science. The implication of this study is to know and describe the level of science concept understanding possessed by 4th grade elementary school students through the results of the tests given systematically and objectively. The data which obtained will be analyzed to determine the extent to which students have mastered the science concepts that have been taught. The results of the study obtained from the the data distribution are in the form of a science concept understanding test. It is known that the average score was 49.14 with the lowest score of 18.75 and the highest score of 87.50. Overall, it can be concluded that the understanding of science concepts of grade IV students in the 2024/2025 academic year is included in the low category because the average score is 49.14.

Keywords: Elementary students, conceptual understanding ability, Science

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INTRODUCTION

Natural Sciences (IPA) is a field of science that allows students to find concepts and facts independently in science material. Science learning at the Elementary School (SD) level aims to develop problem-solving skills, improve understanding, draw conclusions, train objective attitudes, and encourage cooperation and respect for the opinions of others. One important aspect of science learning in elementary schools is students' ability to understand science concepts (Ulandari et al., 2023) .

One of the subjects that must be mastered by students is science. Science is a concept of natural learning and has a very broad relationship related to human life. Science learning plays a very important role in the education process and also the development of technology, because science has an effort to arouse human interest, the ability to develop science and technology, and an understanding of the universe that has many facts that have not been revealed and are still secret. So that the results of the discovery can be developed into new natural sciences and can be applied in everyday life (Handayani, 2018) .

Understanding scientific concepts is crucial because it fosters creativity, enables efficient problem-solving, assists in diagnosing machine malfunctions, and empowers the general public to overcome fear of the unknown, thereby facilitating technological advancement and improving welfare (Fazarinc, 1997). Understanding and applying scientific concepts in daily life and simple technology is one of the goals of education. The ability to understand scientific concepts is very important for students. The concepts understood by students influence their mastery of subsequent concepts, as scientific concepts are interconnected. The understanding of scientific concepts possessed by elementary school students serves as a foundation for grasping other scientific concepts at higher educational levels. Therefore, elementary school students must have a high level of understanding of scientific concepts (Suteja et al., 2022).

Elementary school education forms the basic level of education for students. It contributes to building a knowledge foundation that students will use in subsequent levels of education. Consequently, learning at the elementary school level must be conducted optimally. Natural Science (IPA) as a subject in elementary schools is designed to equip students with knowledge, ideas, and concepts obtained through experience and a series of scientific processes. The scope of learning materials encompasses two aspects: scientific skills and conceptual understanding. Students are required to master both aspects because one of the objectives of science education in elementary schools, as stated in the National Education Minister Regulation No. 22 of 2006, is to develop knowledge and understanding of scientific concepts that are useful and applicable in everyday life.

Science subjects in elementary schools must be tailored to the characteristics and cognitive development of students. Thus, the primary focus of science learning is to utilize scientific processes, which include skills such as observing, classifying, measuring, communicating, predicting, and concluding. Additionally, one of the essential abilities that students need to master is understanding scientific concepts (Aen & Kuswendi, 2020). Elementary school students can learn about the Nature of Science (NOS) after receiving appropriate instruction through strategies such as integrating NOS into the existing curriculum, classroom interactions, visual representations, and student writing (Akerson, 2019). NOS encompasses knowledge about how science operates, including its products, processes, and properties. This includes empirical, tentative, subjective, creative, theoretical, legal, socio-cultural, and scientific dimensions, which are essential for understanding scientific inquiry (Pratiwi, 2023).

Science learning in elementary schools aims to foster students' positive attitudes toward problem-solving in community environments through observation, question-and-answer activities, and data analysis (Nur'ariyani, 2023). Understanding scientific concepts is vital for elementary school students as it facilitates their learning process and helps them comprehend the nature and development of scientific knowledge (Schiefer, 2017). Science involves efforts to understand nature, encompassing knowledge mastery such as facts, concepts, or principles, and the processes of discovery. This involves a series of steps undertaken with a scientific attitude to produce an outcome or product. However, many students still view science learning as merely memorizing formulas or scientific products. In reality, students should also be able to explain the processes behind those scientific products. Thus, science is not merely about memorization but about understanding processes (Budiarso et al., 2020).

Science learning is crucial for children's lives as it is directly related to human life and the universe. Teachers need to understand that science must be taught correctly, as it provides children with the opportunity to develop critical thinking skills. Before reaching this stage, children need to go through phases of exploration, concept introduction, and concept application. Science learning in elementary schools requires a basic understanding of the concepts in each learning unit (Deliany et al., 2019).

According to Anderson & Krathwohl (2010), the cognitive process in the "understanding" category (C2) involves several stages. First, interpreting information by transforming it into another form, such as paraphrasing or describing an illustration in words. Second, exemplifying, which involves providing suitable examples for a concept or principle. Third, classifying, which entails recognizing that an object belongs to a particular category based on its characteristics. Fourth, summarizing, which involves presenting understood information in a concise form. Fifth, concluding, which includes formulating a principle or concept by identifying patterns among the given examples. Sixth, comparing, which involves recognizing similarities and differences between objects or ideas and connecting them to existing knowledge. Lastly, explaining, which involves describing a cause-and-effect model within a system, based on theory, research, or experience.

Despite these educational objectives, many elementary school students (Yolanda & Meilana, 2021) perceive science as a difficult subject. Science learning for elementary school students also aims to help them solve problems, build understanding, draw conclusions, form objective attitudes, collaborate, and respect others' opinions. One critical aspect of science learning in elementary schools is the ability to understand scientific concepts (Novanto et al., 2023).

The learning process so far has not effectively developed students' conceptual understanding. Classroom learning is often directed solely at students' ability to memorize information. Students' brains are forced to remember and accumulate various pieces of information without being required to understand it or relate it to everyday life situations. Furthermore, students have not been taught to understand the concepts behind the learning material. They are only expected to produce good learning outcomes or meet minimum competency criteria, neglecting the actual learning process. As a result, many students "understand without truly understanding," meaning that their knowledge ends as soon as science learning concludes (Fajrie et al., 2023). Low understanding of scientific concepts among students can be attributed to several factors, including a lack of reading habits, low awareness of reading books or materials, and the tendency of students to read only when prompted by teachers (Erina Susanti et al., 2021).

Science learning should help students understand scientific concepts rather than merely memorize or accumulate information without grasping its meaning. Understanding concepts in science learning is a vital component of learning outcomes, encompassing scientific facts. Science learning activities aim to optimize students' knowledge and understanding of scientific concepts (Aen & Kuswendi, 2020).

Research shows that fifth-grade students at SDN 1 Nagarawangi exhibit low understanding of scientific concepts, particularly regarding the properties and changes in the state of matter. This low understanding significantly impacts their foundational knowledge, which is critical for future learning. Misunderstandings arise from associative thinking, contextual influences, incorrect intuitions, and teaching methods. Thus, it is essential for educators to address these misunderstandings to effectively enhance students' understanding of scientific concepts (Safitri, 2024). Studies also reveal that elementary school teachers possess a low understanding of the importance of scientific concepts (Widodo, 2017).

Based on the above explanation, this study aims to describe the level of scientific concept understanding among fourth-grade elementary school students and analyze differences in their understanding across indicators. This study is expected to provide deeper insights into the scientific concept understanding abilities of fourth-grade elementary school students.

METHODOLOGY

This study used quantitative approach with a survey method, the data in this study were taken from the distribution of tests to respondents. Data was collected through concept understanding

tests to gain a view of elementary school students' conceptual understanding in science. The purpose of this study is to describe the level of science concept understanding possessed by 4th grade elementary school students through the results of the tests given systematically and objectively. The data which obtained will be analyzed to determine the extent to which students have mastered the science concepts that have been taught. The population in this study were 30 fourth grade students.

The data collection method in this study used a test technique. The test was designed to measure the understanding of science concepts of 4th grade elementary school students, which will then be analyzed to determine the extent to which students have mastered the material that has been taught. This test technique is used to obtain quantitative data that describes the level of students' understanding of science concepts. The tests applied are in the form of analysis tests in the form of multiple choices and essays on the concept of changes in the state of objects. After the data is obtained through the test, the next step is data processing. This stage is very important to determine how the data is obtained and grouped per indicator of understanding of science concepts. The scores that have been obtained are then processed so that researchers can determine the criteria for students' conceptual understanding scores as follows.

Table 1. Criteria for students' conceptual understanding scores (Mawaddah & Maryanti, 2016)

Criteria	Percentage score
Very Good	85-100
Good	70 – 84
Enough	55 – 69
Low	40 – 54
Very Low	<40

RESULTS AND DISCUSSION

The results of the study obtained from the results of data distribution in the form of a science concept understanding test. It is known that the average value obtained by grade IV students of is 49.14 with the lowest value of 18.75 and the highest value of 87.50. There are 8 students who get scores with very low criteria, 9 students get scores with low criteria, 6 students get scores with sufficient criteria, and 6 students get scores with good criteria. Student scores can be seen in the following diagram.

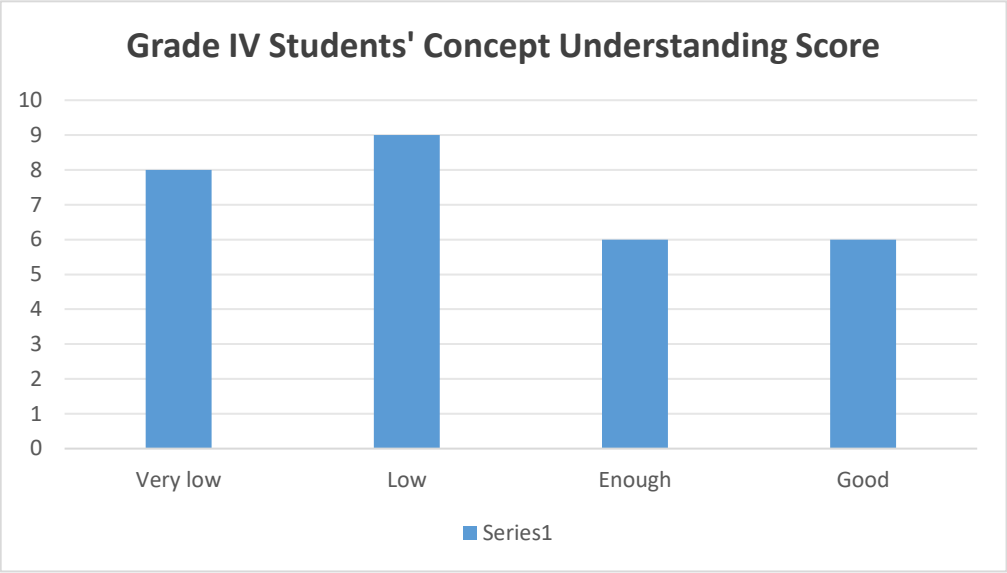

Figure 1. Grade IV students' conceptual understanding scores

The average conceptual understanding score of grade IV students was 49.14, which is in the low category. This is in line with research conducted by Safitri (2024) that elementary school students' understanding of science concepts is low due to misunderstandings arising from associative thinking, contextual influences, wrong intuitions, and ineffective teaching methods used by educators, which hinder the instillation of appropriate basic scientific concepts. The alleged low conceptual understanding is also caused by teacher-centered learning methods. Students only receive conceptual information from classroom teaching (Kelelufna & Ika, 2023). The lack of conceptual understanding experienced by students is caused by various factors. Some of them are the lack of student learning readiness and the learning methods applied by teachers which only include recording concepts without being accompanied by demonstrations or direct practice (Suryani, 2018).

There were 17 students who were declared incomplete and 12 students were declared complete with good and sufficient criteria. Students who got good criteria got a score of 70 to 87. Overall, it can be concluded that the understanding of science concepts of grade IV students in the 2024/2025 academic year is included in the low category because the average score is 49.14.

The low understanding of science concepts is also influenced by the effectiveness of teacher teaching. This low understanding of science concepts in students should be a motivation for teachers to improve the quality of meaningful learning and student learning outcomes. This improvement can be done through the use of appropriate learning strategies and methods, as well as more interesting learning media, so that students' understanding of science concepts is

expected to improve. Teachers also need to conduct regular and continuous evaluations of the material taught in schools. This evaluation aims to determine the extent to which students have mastered and understood the subject matter. Learning in the classroom will be effective if teachers apply the right learning strategies and provide more opportunities for students to participate actively. With this approach, students are expected to be able to master and understand science concepts better (Erina Susanti et al., 2021).

The student scores per indicator of conceptual understanding are as follows.

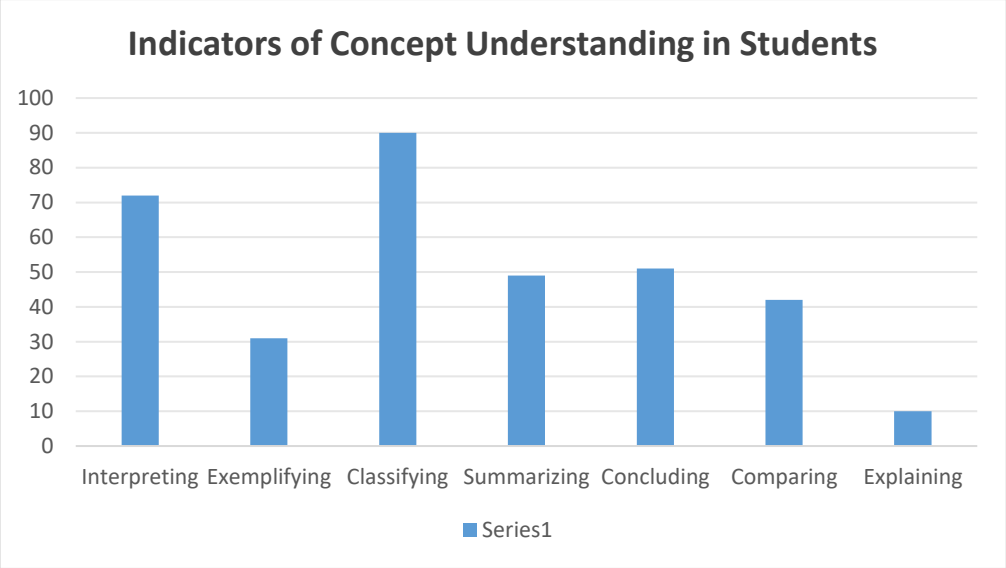

Figure 2. Indicators of Student Concept Understanding

The classifying indicator got the highest score, which was 90. There were 27 students who were able to answer questions with the classifying indicator correctly. Students were able to classify well because they had sufficient understanding of the basic concepts that helped them recognize and group information or objects based on certain characteristics or rules. Students were able to classify liquid objects correctly. The cognitive process of classifying occurs when students know that something or an object is one of a certain category. The classifying process begins by looking at a specific example, after which they find a general principle or concept (Anderson & Krathwohl, 2010).

Meanwhile, the indicator explaining got the lowest score with a value of 10. Only 3 students were able to answer the question of the indicator 'explaining' correctly. Concept understanding according to Duffin & Simpson in Widiawati., et al (2015) can be said to be the ability of students to explain concepts or can be interpreted as students being able to re-express what has been

communicated to them. The process of explaining takes place when students are able to use and create a cause-and-effect model in a system. The model can be developed from a theory or based on research results or experience. The explanation process includes creating a cause-and-effect model, which involves each major component in a system or important event in a series of events. Another term for explaining is making a model (Anderson & Krathwohl, 2010). Many students answered incorrectly on the question on the indicator 'explaining', this is because students do not have a good conceptual understanding of the evaporation process or the process of changing the state of a liquid into a gas. According to Deliany et al., (2019), children's understanding of various concepts that are in accordance with the material they are studying will enable them to achieve effective learning, so that they can meet the desired learning objectives.

In the interpreting indicator, there are 25 students who can answer the question correctly in number 5 regarding the duration of the process of changing the state of a solid object to a liquid or commonly called melting. Students already understand that the larger the volume of a frozen object, the longer the melting process. As for question number 6 regarding the condensation process, 19 students were able to answer the question correctly. In question number 6, students already understand the basic properties of substances and changes in state (from gas to liquid), they will find it easier to understand that condensation is a process in which water vapor in the air turns into water droplets when in contact with a cold surface. The rest did not answer the question correctly. This may be because students do not understand the concept of condensation. According to Syamsidah & Suryani (2018), students who do not understand the concept are different from students who experience conceptual errors. Students who do not understand the concept usually do not understand or have not learned about the concept. Meanwhile, students who experience misconceptions actually already have an understanding, but their understanding is not yet complete or complete, which causes conceptual errors.

In the examplifying indicator, there were 9 students who were able to answer questions correctly about the form of objects. Question number 7 reveals that liquids follow space. Students who answered correctly already understand that liquids really adjust to the shape of their containers, while solids maintain their granular shape, will understand that granulated sugar remains solid even though its shape follows the container. Meanwhile, students who answered incorrectly may be confused because granulated sugar appears to follow the shape of the container when moved. They may think that "following the shape of the container" means the object is a liquid, without realizing the deeper differences. If students have a deep understanding of the properties of objects, it will help students answer this question correctly. According to Susanti et al., (2021) ,

conceptual understanding is the ability to receive, absorb, and understand material or information obtained through a series of events or incidents that can be seen directly or heard that are stored in the mind which can later be applied in everyday life.

In the 'summarizing' indicator, 8 students can summarize a reading text correctly. Students who understand that condensation is a change from gas to liquid can recognize the core of the information in the text and summarize it well. Students who are trained to summarize can focus on the main idea in the text and compose simple sentences that still contain important information. Meanwhile, students who have not received the maximum score on this indicator have less precise answers and the rest have not been able to provide an appropriate summary. Some students may have difficulty identifying core information and abbreviating it effectively. They may include less important details or ignore key information. If students are less familiar with the term "condensation," they may be confused in explaining that this is a change from gas to liquid, and their answers may be less precise or unfocused. Students who are less trained in summarizing may feel the need to rewrite most of the sentences from the text without simplifying them, which results in their answers being less concise or unfocused. The summarizing process occurs when students are able to present a sentence. The sentence must represent the knowledge they have received. Making a summary of knowledge is the process of summarizing. Another name for summarizing is generalizing or abstracting (Anderson & Krathwohl, 2010). A person can be said to understand a concept if he is able to restate the information he has obtained (Deliany et al., 2019).

In the 'concluding' indicator, 18 students were able to answer the question correctly on question number 8 about changes in the state of objects that release heat. Students who understand that cooling occurs because an object releases heat to the environment, in this case, to the air in the refrigerator, will choose option b. Jelly releases heat faster in the refrigerator. They understand that the refrigerator functions to lower the temperature of an object by absorbing heat from the object that is put in. If students have experience putting warm food or drinks in the refrigerator and realizing that the temperature becomes cold, they may better understand that this cooling process occurs because of the release of heat from the food or drink. As for students who answered incorrectly, perhaps words such as "releasing heat" or "capturing heat" are less familiar or confusing for students who have not often heard this concept in the context of cooling.

There are 11 students who can answer the question about drawing conclusions from a text correctly. This question tests students' understanding of thermal insulation and how a thermos maintains the temperature so that ice does not melt quickly. Students who understand that a

thermos functions as an insulator that inhibits heat transfer will understand that the ice in the thermos does not melt quickly because heat from the outside does not easily enter. They will conclude that a thermos maintains cold temperatures longer than a regular bottle. If students have used a thermos and realized that a thermos can maintain the temperature of hot or cold drinks longer, they will find it easier to conclude that a thermos inhibits heat transfer, so that ice does not melt quickly.

Some students answered question number 14 incorrectly about how to maintain temperature. This is predicted because students have not been able to conclude a reading text properly. Or students may not fully understand the function of a thermos. If they think a thermos is only useful for hot drinks or do not understand its role as a temperature insulator, they may not see the relationship between a thermos and the resistance of ice to melting. There are also students who answer incorrectly by interpreting the text and changing its meaning. According to Deliany et al., (2019), conceptual understanding is a person's ability to understand a concept and be able to interpret it correctly without changing its original meaning.

In the 'comparing' indicator, 13 students were able to answer the question correctly. Question number 6, which contains the comparing indicator, tests students' understanding of the thermal conductivity of materials and how different materials affect the rate of cooling. Students who understand that glass has a higher thermal conductivity than plastic and thermoses will know that glass will transfer cold from the freezer to water faster, thereby freezing the water faster. They will choose the correct answer. Students who answer this question incorrectly may not yet understand the concept that different materials have different rates of heat transfer. They may think that all materials will cool water at the same rate, or they may think that plastic is better because it does not retain heat like a thermos.

In the implementation of science learning at the elementary school level, teachers should train their students' critical thinking skills. For example, the ability to understand the basic concepts of a material, apply knowledge and develop the knowledge that has been taught by the teacher. Science learning itself aims to develop and utilize knowledge and basic science concepts in everyday life. Conceptual understanding is the ability of students to master the knowledge given by the teacher as a whole, not just knowing but understanding the knowledge. Thus, students not only know the knowledge but students are able to understand the concept and even apply it in everyday life (Fajrie et al., 2023).

The results emphasize the importance of teaching methods that focus on both conceptual understanding and scientific process skills. Teachers can incorporate inquiry-based learning models, such as discovery learning, to encourage active participation and deeper comprehension of scientific concepts. This study contributes to the growing body of literature on discovery learning and its effect on conceptual understanding and process skills. It provides a basis for further exploration of technology-assisted learning strategies in science education. Future studies should include larger and more diverse sample sizes to increase the generalizability of findings across different schools, regions, and student demographics.

CONCLUSION

The results of the study obtained from the results of data distribution in the form of a science concept understanding test. It is known that the average score obtained by grade IV students is 49.14 with the lowest value of 18.75 and the highest score of 87.50. There are 8 students who get scores with very low criteria, 9 students get scores with low criteria, 6 students get scores with sufficient criteria, and 6 students get scores with good criteria.

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The classifying indicator got the highest score, which was 90. There were 27 students who could answer questions with the classifying indicator correctly. While the explaining indicator got the lowest score with a value of 10. Only 3 students could answer the question of the 'explaining' indicator correctly. In the interpreting indicator, there were 25 students who could answer the question correctly in number 5 regarding the duration of the process of changing the state of a solid into a liquid or commonly called melting. In the 'giving examples' indicator, there were 9 students who could answer questions correctly about the state of objects. In the 'summarizing' indicator, 8 students could summarize a reading text correctly.

In the 'concluding' indicator, 18 students were able to answer questions correctly on question number 8 about changes in the state of objects that release heat. There were 11 students who were able to answer questions about drawing conclusions from a text correctly. Several students

answered question number 14 incorrectly about how to maintain temperature. This is predicted because students have not been able to conclude a reading text well. In the 'comparing' indicator, 13 students were able to answer questions correctly. In the implementation of science learning at the elementary school level, teachers should train their students' critical thinking skills. For example, the ability to understand the basic concepts of a material, apply knowledge and develop knowledge that has been taught by the teacher.

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