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Analysis of Misconception of Grade Vi Science Material on Photosynthesis Theme

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Abstract: This study aims to identify and analyze misconceptions among sixth-grade students at SD Negeri 58 Mojo, Sragen Regency, regarding the concept of photosynthesis using a four-tier test instrument. The research design employed is descriptive quantitative with a sample of 20 students. The instrument consisted of 10 four-tier items based on key indicators of the photosynthesis topic. Data were collected through direct testing and quantitatively analyzed based on the percentage of misconceptions. The results revealed that the highest misconception occurred in identifying the plant part responsible for photosynthesis (80%). Most misconceptions stem from poor conceptual understanding of leaf structure and chloroplast function. These findings confirm that the four-tier test is effective in diagnosing student misconceptions and can be utilized as a diagnostic tool in science education. It is recommended that teachers use visual-based and hands-on approaches when teaching photosynthesis to minimize misconceptions. Further research could explore the effectiveness of misconception-based learning interventions with a broader population.

INTRODUCTION

Understanding basic concepts in natural science is an important foundation in basic education, especially to form a scientific mindset from an early age. One concept that is an essential part of the Elementary School Science curriculum is the process of photosynthesis. Photosynthesis is key material for understanding ecosystems, the relationship between living things and their environment, and as a basis for advanced biology learning. However, in learning practices, many students still find it difficult to understand this process

comprehensively and scientifically, which often leads to misconceptions.

Misconceptions are erroneous understandings but are believed to be true by students, and can persist in the long term if not corrected through appropriate pedagogical interventions (Treagust, 2006).

In the context of science learning, misconceptions often stem from ineffective learning processes, unrepresentative teaching media, and assessment methods that are unable to deeply reveal students' understanding. One of the science materials that is prone to misconceptions is photosynthesis, which requires conceptual and processual understanding, as well as its relationship to real natural phenomena. Several previous studies have stated that students have difficulty in recognizing the role of chlorophyll, plant parts involved in photosynthesis, and materials and results of the photosynthesis process (Hasnunidah et al., 2021; Widiyatmoko & Shimizu, 2018).

Several previous studies have shown that students tend to have misconceptions about the origin of plant food, the role of sunlight, and the process of energy conversion in photosynthesis (Haslam & Treagust, 1987; Çalik et al., 2006; Kose, 2008). Research by Aydın & Coşkun (2011) states that these misconceptions can continue into secondary education if not identified early on. Therefore, early detection of misconceptions is a strategic step in the learning improvement process.

The use of conventional evaluation instruments is often unable to detect misconceptions in depth, because it only measures declarative knowledge without assessing students' beliefs and reasons for their answers. Putri and Rahayu (2020) developed and implemented a two-tier diagnostic test to detect misconceptions among elementary students in basic science concepts, this study serves as a foundational reference for the development of more advanced diagnostic models, such as the four-tier test, which can further measure the confidence level and reasoning patterns of students regarding photosynthesis concepts in Grade VI science learning. To overcome these limitations, a four-tier test diagnostic instrument was

developed that allows educators to assess students' understanding based on answer choices, reasons, and levels of confidence in both (Caleon & Subramaniam, 2010). Several studies have adapted and developed this instrument in the context of photosynthesis material with significant results in revealing hidden misconceptions (Peşman & Eryilmaz, 2010; Wang, 2020; Fauzi & Widodo, 2022).

Different from previous studies that generally focus on junior high and high school levels, this study specifically examines misconceptions in grade VI elementary school students, a level where the basics of science concepts begin to form systematically. This study also uses a modified four-tier test according to the cognitive characteristics of elementary school students, which has not been widely reviewed in the literature. Thus, this study has scientific novelty in the form of applying an advanced diagnostic method (four-tier test) to the context of elementary education in photosynthesis material.

The purpose of this study was to identify and analyze the misconceptions of grade VI students of SD Negeri 58 Mojo, Sragen Regency regarding photosynthesis material using the four-tier test instrument. The results of this study are expected to be the basis for developing more targeted learning strategies in forming correct scientific understanding since elementary education.

METHOD

This study is a quantitative descriptive study that aims to identify and analyze students' misconceptions on photosynthesis material using a four-tier test instrument. The design of this study does not aim to test hypotheses, but rather to describe the real conditions of students' understanding based on quantitative data from the results of diagnostic tests.

The subjects of this study were 20 sixth grade students of SD Negeri 58 Mojo, Sragen Regency. Subject selection was carried out by total sampling because the number of students was relatively small and the entire population was considered representative for the purpose of exploring misconceptions in a limited scope.

The main instrument in this study was a four-tier diagnostic test developed based on the learning indicators of photosynthesis material in the Merdeka Curriculum for Elementary School level. The instrument consists of 10 questions, each of which contains four layers: (1) multiple-choice content questions, (2) confidence in content answers, (3) multiple-choice conceptual reason questions, and (4) confidence in the reasons given. The questions have gone through a content validation process by three science education experts and a readability test by a sixth grade teacher at another school with similar characteristics.

The data collection procedure began with an explanation to teachers and students regarding the purpose and mechanism of filling out the test. Furthermore, the four-tier test was distributed to all sixth grade students to be completed individually within 60 minutes under the supervision of the researcher and class teacher. After collection, the answer sheets were coded and analyzed manually using answer classification guidelines based on a combination of choices and student confidence levels. Students' answers were categorized into four groups, namely: scientific understanding, misconceptions, not knowing the concept, and not sure. Data analysis was carried out by calculating the percentage of students in each category for each question item and indicator. The main focus of the analysis was to identify items or indicators with the highest percentage of misconceptions, as a basis for drawing conclusions and recommendations**.**

RESULT & DICUSSION

This study aims to analyze the misconceptions of sixth grade students of SD Negeri 58 Mojo, Sragen Regency on photosynthesis material using the Four-Tier Test instrument. The results of data processing show that the level of students' misconceptions varies in each indicator of photosynthesis material.

Result

The results of the study on the misconceptions of sixth grade students of SD Negeri 58 Mojo, Sragen Regency related to photosynthesis material using the four-tier test instrument. The results of the analysis of 20 students show that the level of misconceptions varies in each indicator. Table 1 shows the

percentage of students who experience misconceptions in each indicator.

Table 1. Percentage of students who experience misconceptions in each indicator.

No	Indicator Material Photosynthesis	Percentage Misconception	Category
1	Explaining the meaning of photosynthesis	35%	Low misconception
2	Mentioning the main ingredients of photosynthesis	30%	Low misconception
3	Mentioning the main results of photosynthesis	35%	Low misconception
4	Identifying plant parts that play a role in photosynthesis	80%	High misconception
5	Explaining the role of chlorophyll in photosynthesis	30%	Low misconception
6	Mentioning the benefits of photosynthesis for humans	25%	Very low misconception
7	Explaining the relationship between photosynthesis and the environment	15%	Very low misconception
8	Explaining the process of photosynthesis in a simple way	25%	Very low misconception
9	Identifying autotrophic plants through photosynthesis	20%	Very low misconception
10	Showing examples of plants that carry out photosynthesis	35%	Low misconception

Discussion

Based on Table 1, indicator 4, namely identifying plant parts that play a role in photosynthesis, has the highest level of misconception at 80%, which is included in the high misconception category. This indicates that most students do not understand that leaves, especially mesophyll tissue containing chloroplasts, are the main place where photosynthesis occurs (Taiz & Zeiger, 2010). Many students assume that roots or stems are the main organs that carry out photosynthesis, possibly because they see roots as "food suppliers" or think that green stems also perform this function significantly

The results of this study indicate that although most students have understood the basic concept of photosynthesis, there are still significant misconceptions in aspects involving biological structures (indicator 4). This finding is in line with the research of Ozay and Oztas (2003) which stated that students often ignore the physiological role of leaves in the process of

photosynthesis and assume that all parts of the plant generally play an active role in the process. This phenomenon indicates that students experience structural misconceptions, namely errors in connecting the morphological structure of plants with their physiological functions (Çalik et al., 2010). This error is exacerbated by the use of textbooks or learning media that do not clearly display illustrations or microscopic diagrams of chloroplasts (Tekkaya, 2002). Students tend to generalize that all green parts of plants carry out photosynthesis in the same capacity, even though leaves have a much higher concentration of chloroplasts than other parts (Campbell et al., 2018). Another study by Amita et al. (2021) also found that 72% of elementary school students had difficulty identifying the main location of photosynthesis. Likewise, Widiyatmoko (2020) stated that this misconception arises from verbal learning and minimal experiments. The use of microscopes or 3D chloroplast models in learning has been shown to significantly reduce these misconceptions (Ünal et al., 2006).

The four-tier test instrument has been shown to be effective in revealing not only wrong or right answers, but also the reasons and level of students' confidence in their answers (Caleon & Subramaniam, 2010). These findings support a previous study by Sari et al. (2020) which showed that students who experience misconceptions generally answer incorrectly with high confidence in the wrong reasons, indicating the need for conceptual intervention through corrective learning strategies.

This misconception is important to correct because it impacts students' understanding of the entire concept of photosynthesis, from the process, the role of light, chlorophyll, to the final result. Without a proper understanding of the location and structure, students will have difficulty linking the biochemical aspects of the photosynthesis process with the function of plant organs.

Overall, this study shows that elementary school students' understanding of the concept of photosynthesis is not yet fully intact, and conventional learning based on lectures and memorization is not enough to build deep conceptual

understanding. Inquiry-based learning, simple experiments, or the use of visual media are needed to minimize misconceptions.

CONCLUSION

This study revealed that sixth grade students of SD Negeri 58 Mojo experienced various misconceptions in photosynthesis material. Based on the results of the four-tier test analysis, the indicator with the highest misconception was "identifying plant parts that play a role in photosynthesis" with a percentage reaching 80%, indicating a fairly significant misconception. Most students assume that plant parts such as roots or stems have a major role in photosynthesis, while leaves, especially mesophyll tissue containing chloroplasts, are the main place where photosynthesis occurs. This indicates the need for improvement efforts in conceptual understanding of plant structure and its function. The use of the four-tier test instrument has proven effective in identifying the level of misconception and the reasons behind students' answers. This instrument provides deeper insight into students' understanding of more complex scientific concepts.

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