

CHAPTER I

INTRODUCTION

1.1 Research Background

Science plays a vital role in the Indonesian education curriculum, aiming not only to equip students with knowledge but also to foster critical scientific skills such as systematic thinking, conceptual understanding, identifying interrelationships between concepts, recognizing causal relationships, and understanding hierarchical structures within scientific domains. Mastery of scientific thinking must be complemented by a deep and accurate understanding of scientific concepts within their appropriate contexts; otherwise, scientific reasoning may lack substance and applicability (Lestari et al., 2023). The effectiveness of science education is heavily influenced by how the content is delivered—through pedagogical strategies, teacher competence, and the quality of learning resources available to students. According to Rosamsi et al. (2019), not only is students' development and depth of scientific knowledge determined by the curriculum alone, but also by the teaching approaches and materials used in the classroom. Contextually relevant, inquiry-based, and interactive teaching approaches are therefore required to allow students to internalize and apply scientific concepts meaningfully.

However, learning science is consistently faced with critical challenges, particularly relating to students' poor understanding of scientific material. This problem is often caused by the abstract and complex nature of scientific information, coupled with technical terminology that could be hard for students to grasp (Umami et al., 2022). As a result, students can develop long-standing and incorrect conceptions of scientific ideas that get in the way of their ability to accurately interpret and apply scientific information. These types of misconceptions typically occur when students try to interpret new information and coordinate it with their existing cognitive frameworks but do so incorrectly or incompletely (Tumanggor et al., 2019). These conceptual misconceptions can persist unless

actively diagnosed and repaired through effective instructional techniques that promote conceptual change and deeper understanding.

One of the fundamental principles of the science of biology is the classification of living things, which gives a means of organizing the vast array of organisms based on similarities and distinctive differences. It is an important principle that helps students to understand broader biological themes, such as the interconnectedness of species, evolutionary patterns, and how organisms adapt with respect to various environmental parameters (Barnes, 2009). However, due to its abstract nature and use of technical terminologies, students find it difficult to accurately grasp classification concepts, making this topic prone to misconceptions. In an attempt to adequately address these issues, several studies have highlighted the significant role played by diagnostic tools in identifying students' misconceptions in biology. These sorts of tools, especially those designed to unveil the level and justification of student thinking, provide valuable data for teachers to design targeted interventions and conceptual understanding.

It is necessary to overcome junior high school students' misconceptions in science learning to provide a strong foundation for future learning. Misconceptions are incorrect interpretations of a concept where a student's comprehension differs from the scientifically accepted definition (Hasanti & Zulyusari, 2021). Among the reasons is that teachers tend not to diagnose students' misconceptions in science learning. This is largely due to the focus on learning indicators that are not specifically geared towards conceptual understanding, which has the unintended consequence of leading to the development of misconceptions among students (Suharto & Csapo, 2022). Misconceptions arise when the prior knowledge of students, which has already been memorized, is in conflict with new scientific concepts being learned (Jayanti & Susantini, 2021). This prior knowledge may be incomplete or incorrect, and it acts as a barrier to acquiring the correct understanding. Haidar et al. (2020) also claim that misconceptions are more likely to be present in students who fail to understand a concept fully during the learning process. As a result, these misconceptions may interfere with the learning of new

information, and it becomes ever harder for students to build correct scientific understanding (Soeharto et al., 2019).

One of the most vulnerable science topics to misconceptions is the classification of living things. This is taught in Grade VII second semester. When students learn the subject of classification without understanding specifically the notion of grouping organisms into groups according to shared characteristics or differentiating features it is difficult for them to describe and differentiate living things appropriately. Consequently, misconceptions are likely to occur. The reason is that most biological concepts are abstract in nature, and hence, they are more difficult for students to comprehend if they are not provided with concrete and meaningful learning experiences (Gultom, 2019).

Misconceptions are misunderstandings of a scientific concept, and can be caused by a number of factors including students' prior knowledge, instructional methods, media use, and an unsupportive learning environment (Fitriyani & Saputro, 2020). To understand the context in which misconceptions arise among public junior high school students in East Bandung, it is necessary to analyze relevant educational statistical data. The National Assessment (AN) measures basic competencies in reading literacy and numeracy that are important for all subjects, including science. According to the Education Assessment Center (2022), the 2021 AN results show that as many as 47% of junior high school students in Indonesia are in the low literacy category, indicating that students have difficulty in understanding, evaluating and reflecting on scientifically presented information. “One of the challenges in science literacy is how students build deep conceptual understanding, not just memorizing scientific facts.” (Pusmendik, 2022). This data can be used as a basis for linking low literacy scores with potentially high misconceptions, especially in abstract material such as the classification of living things.

School accreditation reflects the overall quality of the education unit, including the quality of learning and the competence of educators. Based on data from BAN-PDM (2023), in Bandung City there are 18 public junior high schools that have not been accredited A. Teachers who do not have the appropriate scientific

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background or lack of pedagogical mastery have the potential to deliver material in an inappropriate way. According to Susanti & Nuryani (2020), non-linear teachers tend to simplify the material to facilitate student understanding, but instead reinforce misconceptions. “When teachers convey concepts with inaccurate or overly simplistic analogies, students can absorb misinformation and construct it as scientific truth.” (Handayani, 2022).

Data from the Bandung City Education Office (2023) shows that the ratio of teachers and students in several public junior high schools in the East Bandung area is still high, ranging from 1:35 to 1:45. This condition causes limited opportunities for teachers to identify students' misconceptions individually. According to research by Surya & Suryani (2019), this high ratio causes weak feedback on students' conceptual errors during the learning process. “Misconception correction requires in-depth interaction between teachers and students, which is difficult to realize optimally in a class with a large number of students” (Surya & Suryani, 2019). In addition, limited laboratory facilities and teaching aids also play a big role. Without hands-on practice, students have difficulty understanding real science concepts, which increases the possibility of forming misconceptions (Widodo, 2021).

The implementation of new system of curriculum based on contextual and project learning (P5) aims to avoid rote learning. However, not all schools in East Bandung have implemented it optimally. According to data from Kemendikbudristek (2023), only about 64% of public junior high schools in Bandung have implemented the Merdeka Curriculum independently. Schools that have not fully implemented this curriculum tend to still use a lecture approach, which does not encourage independent exploration of concepts by students. “When students do not learn in a context that is relevant to their daily lives, the concepts learned tend to be meaningless, and this is the main cause of misconceptions.” (Lestari & Kurniawan, 2020).

Misconceptions have the potential to significantly impede students' ability to learn and understand new material if they are not identified and resolved in a timely fashion (Hasanti & Zulyusri, 2021). One of the most effective ways to

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determine these misconceptions is by using diagnostic tests (Putri & Ermawati, 2021). Diagnostic tests aim to uncover students' misconceptions or weaknesses in conception, and the results can be used to inform targeted instructional interventions for the misconception-holders (Febriyana et al., 2020). Several diagnostic tests have been developed for this purpose, from two-tier, three-tier, four-tier, to even five-tier diagnostic tests. According to Kartimi et al. (2021), a four-level diagnostic instrument was developed to investigate elementary students' misconceptions across various science subjects.

This instrument, with answer choices, self-report confidence and rationale ratings for justifying reasoning, was successful in revealing a large proportion of student misconceptions and highlighting the need for valid and reliable diagnostic measures in classrooms. Their study underscores the ability of such instruments to not only identify misconceptions but also to help teachers understand better students' thought processes. Complementing this, Bashir (2024) emphasizes the importance of formative assessment measures, which supplement the diagnostic process through continuous monitoring of learners' understanding and the provision of timely, targeted feedback. Of specific concern, the four-tier diagnostic test has been well respected for its effectiveness in identifying misconceptions in a sophisticated manner and enabling sound information for instructional design purposes that address student misunderstandings directly and promote conceptual change. A number of diagnostic tests have been developed to identify and examine student misconceptions, each offering various strengths in the ways students handle scientific concepts.

Some of the most common formats include open-ended questions, multiple-choice, tiered diagnostic tests, and structured interviews (Juliani et al., 2021). Multiple-choice tests are used most because they are easy to use and effective in assessing students' grasp of particular concepts (Sari & Abdurrahman, 2019). While open-ended questions allow teachers to gain improved insight into the thinking and reasoning of students, multiple-choice questions are of greatest utility in assessing both conceptual understanding and the level of confidence with which students provide their responses. To provide greater diagnostic precision, such tests can be

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structured into multi-tiered forms of two-tier, three-tier, or four-tier diagnostic tests that include other features like reasoning options and ratings of confidence. These layers enable teachers to distinguish between surface-level lack of knowledge and deeply embedded misconceptions, and they are therefore valuable tools in the direction of focused instruction.

1.2 Research Problem

Based on the background which has already been stated, this research states the problem as “How can four-tier diagnostic test be used to assess students’ conceptions about the classification of living things in East Bandung Region? Based on research problem state, the research question following these questions below:

- a. What is students’ conception about classification of living things as assessed by four-tier diagnostic test?
- b. What are the most common students’ misconceptions in each sub-topic on the classification of living things topic in junior high school?

1.3 Operational Definition

a. Students’ Conception

Student conceptions are the understanding that student have about a particular concept or subject that have learn before. There are five types of conception assessed by four-tier diagnostic test based on the response to the four-tiers. Scientific knowledge means students correctly answer with confidently. False positive means students answer first-tier is correctly and third-tier is incorrectly but confidently. Conversely, false negative means student answer first-tier is incorrectly and third-tier is correctly, but confidently. Misconceptions means students incorrectly answer with confidently. Lack of knowledge means students answer is not confidently.

b. Students’ Misconception

Student misconceptions are an incorrect understanding or misperception that students have about a scientific concept. Misconception occurs when students construct knowledge that is incompatible with scientifically accepted concepts. Misconceptions tend to result in errors in the comprehension of ideas at higher levels because students have a mistaken foundation. Four-tier diagnostic test is one of the diagnostic tests that are more accurate to identify student misconceptions than the usual tests.

c. **Four-Tier Diagnostic Test**

The four-tier diagnostic test instruments are designed to assess students' conception of the topic. The first-tier is main question, while the second-tier is measuring confident level for the main question. The third-tier is reason of main question, while the fourth-tier is measuring confident level for the reason. In both confident level tiers, students can choose between two options, such as "confident" or "not confident" (Kiray & Simsek, 2021). Students' answer is analyzed to identify their conceptions and conduct statistically to categorize the students' conception.

1.4 Research Objective

This research has the objective described as follow:

- a. To analyze the conception about topic on junior high school students using four-tier diagnostic test.
- b. To categorize the most common misconception in each sub-topic among junior high school students on the classification of living things.

1.5 Research Benefit

a. **For Students**

This research helps students in measuring and correcting their misconceptions concerning the classification of living things, especially to

build conceptual accurate knowledge. By removing these misunderstanding, students are able to enhance academic performance and their ability to effectively learn scientific concepts. Besides, learning through methods that aim at addressing misconceptions improves critical and analytical capacity, which predisposes students to utilize the knowledge in real-life situations.

b. For Teachers

This research is beneficial to teachers as an experiential guidebook for familiarization with the general challenge faced by students in the topic of classification of living organisms. It provides comments on specific topics where there is misunderstanding, enabling teachers to enhance their teaching. The research can also initiate the development of inquiry-based and interactive learning models, thereby involve lessons and enhance their efficiency. This is not only enhancing teaching quality but also enhancing the teacher's professional certification.

c. For Researchers

This research providing insight about misconception in the learning of science, with domain biology. It serves as a background for the following studies, for instance, testing new assessment tools or intervention methods to correct students' misconceptions.

1.6 Scope of Research

The diagnostic instrument will be built from open-ended questions in a pilot study, and the multiple-choice items were then built to represent each concept. The four-tier diagnostic test is a diagnostic instrument to measure students' concepts, which consists of four tiers: the main question and the confidence level for the reason. The confidence level in this study has only two options: confident and not confident (Kiray & Simsek, 2021). The study material consists of materials in the module on

the classification of living things in the existing curriculum. The population sample is junior high school students who have learned about the classification of living things in the East Bandung Region.