

CHAPTER I

INTRODUCTION

1.1 Research Background

Understanding the concepts being studied is one of the learning objectives that must be achieved by students so that they are able to apply such concepts in their daily lives (Wulandari et al., 2021; Luzyawati & Hidayah, 2019). Students' learning experiences are an important thing in achieving mastery and comprehension of a concept. However, throughout the learning process, students may not always receive complete information provided by the teacher (Istiyani et al., 2018). This happens because students already have preconceptions that are derived from their everyday life experiences before entering the class (Ausubel, 2000; Hunaidah et al., 2022). Unfortunately, students' preconceptions often lead to inaccuracies; inaccuracy can be caused by the fact that students do not yet realize that their personal experience is only one piece of the vast world of knowledge so it can lead to misconceptions (NTSA, 2013).

Misconceptions refer to students' conceptions that is different from the scientific view of a concept and steadfast in their ways (Gurcay & Gulbas, 2015; Kaltakci-Gurel et al., 2017). Misconceptions can prevent students from developing the correct concepts that serve as the foundation for more advanced learning and understanding of scientific phenomena (Soeharto et al., 2019). In other words, misconceptions can interrupt students' ability to understand science effectively and comprehensively. If misconceptions are not identified from the beginning, students find it difficult to grasp the subject, creating a barrier to knowledge reformation and leading to challenges in achieving success in future learning experiences (Vrabec & Proksa, 2016). Misconceptions in science are persistent, challenging to correct, and deeply rooted in certain ideas. Therefore, it is crucial to eliminate or clarify misconceptions as soon as possible (Soeharto et al., 2019). To eliminate misconceptions, they should be identified first (Irmak et al., 2023).

Different measurement tools are developed and used to diagnose misconceptions in students (Kiray & Simsek, 2021). Researchers have developed and used many diagnostic tools such as concept maps (Plotz, 2020), interviews (Jusniar et al., 2020), open-ended or free-response questionnaires (Wittman, 1998),

word association (Maskill & Cachapuz, 1989), drawings (Ehrlén, 2009), multiple-choice tests (MCTs) (Lamichhane et al., 2018), and multiple-tier tests with two-tiers (Tsui & Treagust, 2010), three-tiers (Peşman & Eryilmaz, 2010) and four-tiers (Caleon & Subramaniam, 2010). Interviews offer valuable insights into students' deep cognitive structure but can be time-consuming to gain greater generalizability. On the other hand, MCTs provide an efficient way to gather data from numerous participants but lack the ability to investigate answers in-depth (Kaltakci-Gurel et al., 2017). To address this limitation, multiple-tier tests have been developed. These tests aim to differentiate between correct answers and the reasoning behind them (Caleon & Subramaniam, 2010).

A multiple-tier test is an instrument with several levels or tiers. The first developed version was the two-tier multiple-choice test by Treagust (1988), which developed from the multiple-choice items with a format identical to the 'Test of Logical Thinking' by Tobin & Capie (1981). Each test topic consists of a first-tier multiple-choice question with two or three options and a second-tier with four potential reasons for the response. The reasons tier includes the correct response, identified misperceptions or misconceptions, and straightforward incorrect responses, if needed (Treagust, 1988). However, two-tier tests could not differentiate between a lack of knowledge and misconception (Taban & Kiray, 2022), leading to the development of three-tier tests as replacements.

The three-tier diagnostic test is a continuation of the two-tier test development developed by Treagust (1988) (Istiyani et al., 2018). Peşman & Eryilmaz (2010) later introduced a three-tier test that combines the two-tier test with the Certainty of Response Index (CRI), using a Likert-type scale to measure students' confidence in their answers. The three-tier test comprises the content tier, the reason tier (asking for the reason behind the content answer), and the confidence tier which measures students' confidence in their response (Kiray & Simsek, 2021). This test helps identify misconceptions and knowledge gaps, in addition, this test also can distinguish between false positive and false negative conditions (Istiyani et al., 2018). However, it still needs improvement in differentiating confidence choices between the main answer in the first tier and reasoning in the second tier.

The four-tier diagnostic test which was developed by Caleon & Subramaniam (2010), includes a confidence tier after the content tier (Taban & Kiray, 2022). The four tiers are tier-content, tier-confidence, tier-reason, and tier-confidence (Caleon & Subramaniam, 2010). This test effectively distinguishes confidence levels in answers and reasons, to explore a deeper understanding of concepts. Thus, four-tier test was claimed to provide the most valid misconception judgment than the three-tier and two-tier tests (Resbiantoro et al., 2022). Research by Kaltakci-Gurel et al. (2015) compared several diagnostic tests to detect misconceptions, revealing that the four-tier diagnostic test was more accurate in identifying misconceptions than other tests (Rahmatika & Utami, 2021).

Indonesian students' achievements in science were ranked the lowest in the 2018 PISA, encompassing 41 nations as its focus group (OECD, 2020). Therefore, this is crucial to address the issues related to the difficulty of science concept to enhance students' learning outcomes (Soeharto & Csapó, 2021). There are various studies have been undertaken to explore students' conceptions of science across a range of fields such as chemistry, physics, and biology. According to Soeharto et al. (2019), there is still lack of research that investigate students' conceptions of biology using four-tier diagnosing test. In biology, the difficulty in understanding the concepts that lead to misconceptions stems from the concept complexity and scientific words (Irani et al., 2020). In addition, the hidden aspects related to natural phenomena also causes biology difficult to learn (Kumandaş et al., 2018).

Prayitno & Hidayati (2022) find that the highest students' misconceptions related to general biology is about the definition of biology (65%) followed with the concept of biological systems controlled by feedback mechanisms (62%). The concept of biological systems controlled by feedback refers to the regulatory processes within living organisms that maintain homeostasis by monitoring and adjusting various physiological or biochemical activities in response to changes, this could involve processes such as hormone regulation, enzyme activity, neural signaling, and more. Human excretion is one of biology topic that contributes to maintaining homeostasis by eliminating waste products, this topic taught in grade eight of junior high school in the second semester under the 2013 National Curriculum by the Indonesian Ministry of Education. Through this topic, the

government expects students to be able to understand the importance of the excretory system to keep the body healthy by carrying out its function to maintain homeostasis and link it to a healthy lifestyle (Lestari et al., 2021).

Several studies have been conducted to identify students' misconceptions about human excretion using two-tier and three-tier tests for junior high school students (Mardiani et al., 2020; Aprilanti et al., 2016; Luzyawati & Hidayah, 2019; Dahlina et al., 2019), and a four-tier test for senior high school students used a Likert Scale that divided on a scale of one to six for the confident tier (Wilantika et al., 2018). The research found that 21.14% of students experienced misconceptions about human excretion (Dahlina et al., 2019). Another study discovered that students had misconceptions in several concepts, such as the composition and physical properties of urine (48%), the liver as an excretory organ (44%), and the lungs as an excretory organ (29%) (Aprilanti et al., 2016). Misconceptions that occur on this topic considered to have serious difficulties related to the concepts, processes, symptoms, and phenomena involved (Luzyawati & Hidayah, 2019). Furthermore, there are also many scientific words that students must understand, which become one of the difficulties in understanding this topic (Wilantika et al., 2018).

Therefore, based on previous descriptions this research focuses on identifying misconceptions about human excretion held by junior high school students using a four-tier diagnostic test. Unlike the previous research, this research examines junior high school students' misconceptions about human excretion using a four-tier diagnostic test with binary confidence tier ("Sure" or "Not Sure") to enhance accuracy in identifying misconceptions (Kiray & Simsek, 2021). Misconceptions will severely impact students' future learning. Consequently, it is important to identify students' misconceptions.

1.2 Research Problem

Based on the background, the research problem of this study can be defined as “How is the four-tier diagnostic test used to identify misconceptions held by junior high school students about human excretion?”. In order to investigate the research problem, the following questions have been formulated as follows:

- 1) What is the profile of students' conceptions about human excretion?
- 2) What are the common students' misconceptions about human excretion?

1.3 Operational Definition

1) Students' Conceptions

Students' conceptions can be defined as students' beliefs or ideas that take shape of things developed throughout their experience both within inside and outside of the school. The level of students' conceptions is diagnosed based on students' answers to the four-tier test questions. There are 5 levels of students' conceptions which are scientific knowledge, lack of knowledge, misconception, false negative, and false positive.

2) Misconceptions

Students' misconceptions are defined as student conceptions that contradict to the scientific view. The misconceptions are detected when students confidently give incorrect answer both of the first-tier and third-tier questions in the four-tier test.

3) Four-Tier Diagnostic Test

A four-tier diagnostic test is an instrument used to measure students' misconceptions which form a multiple-tier that consists of four tiers. The first tier is the main question with four options, which consists of three distractors that address specific misconceptions and one key answer. The second tier asks about the confidence of the answer in the first tier. The third tier asks for the reasoning for a question in the first tier with four options closed-ended questions, and the fourth tier is the tier that asks for the confidence of the third tier.

1.4 Limitation of Problem

The limitations of this study are as follows:

- 1) The science concepts employed in this research cover the human excretion topic in 8th grade, which is limited by Core Competence number 3 and Basic Competence number 3.10 which was developed in the 2013 National Curriculum by the Indonesian Ministry of Education.
- 2) The instrument used in this research is a four-tier diagnostic test consisting of four tiers which are tier-content, tier-confidence, tier-reason, and tier-confidence with the confidence tier uses binary logic such as "sure/not sure". This instrument solely identifies students' conceptions; it does not delve into the underlying causes of why misconceptions can arise in students.

- 3) The sample is limited to grade 8 junior high school students who have studied the topic of human excretion in the 2013 National Curriculum.

1.5 Research Objective

This research objective is described as follows:

- 1) Investigate the profile of students' conceptions about human excretion.
- 2) Investigate the most common students' misconceptions about human excretion.

1.6 Research Benefit

This research can be beneficial for teachers as it helps them identify students' misconceptions about human excretion. With this result, teachers can design more effective teaching strategies to help students grasp the concept and overcome their misconceptions. Additionally, this study offers valuable insights into students' understanding of human excretion, enabling them to strengthen their knowledge and improve learning outcomes. Moreover, the information, data, and instruments on students' misconceptions of the human excretion topic obtained from this study can be utilized by future researchers to diagnose and address students' misconceptions effectively.

1.7 Organizational Structure of Research Paper

Chapter I: Introduction

This chapter contains the research background, research problem, operational definition, limitations of problem, research objectives, research benefits, and the organizational structure of the research paper.

Chapter II: Literature Review

This chapter presents a literature review of important variables, including students' understanding of scientific concept, students' misconceptions, the four-tier diagnosing test, and the human excretion topic.

Chapter III: Research Methodology

This chapter explains the research process, including the research design, research method, participants, research instruments, instruments analysis, data collection, and research procedures.

Chapter IV: Results and Discussion

This chapter presents the findings of the data analysis and includes a discussion based on the results.

Chapter V: Conclusions, Implications, and Recommendations

This chapter presents the conclusions drawn from the results and discussions, as well as implications and recommendations for future research.