

CHAPTER I

INTRODUCTION

1.1 Research Background

Science is one of the learning contained in the curriculum in Indonesia. In Science, students should be able to understand comprehensive concepts such as systematic thinking, concept understanding, relationships between concepts, causality relationships, and the level of hierarchy of a concept, because scientific thinking alone will not advance science if it is not accompanied by an understanding of science concepts according to the scope of each content (Lestari, 2021). Science understanding by a student is influenced by several factors, including logical reasoning and prior knowledge of the topic (Kasiara et al., 2019). Teaching methods and learning resources also influence scientific knowledge development (Rosamsi et al., 2019). These cognitive and learning styles, which influence the development of scientific knowledge on a larger scale, helps the students to grasp scientific concepts.

However, in the process, it is not uncommon to find several obstacles, such as the lack of optimal understanding of the material due to difficult to understand concepts and complicated terms that cause misconception (Umami, 2022). Misconception is an inappropriate concept understanding based on what has been tested and validated by experts. Misconceptions among students can have profound and lasting consequences for their academic journey because once formed, they will tend to persist, affect subsequent learning, and create a cycle of misunderstandings (Wahyuni, 2022). This will cause problems in science, because basic concepts serve as the basis for more complex understanding. The circulatory system is a prime example of how misconceptions can impact learning.

The circulatory, or cardiovascular system, is a set of organs that work together to perform the vital function of carrying blood from the heart to all parts of the body and back again (Ningrum et al., 2022). Learning about the circulatory system is expected to be relevant to the students as they learn about how their bodies function, while also

contributing to their awareness and action in terms of their health. Making wise lifestyle choices will help prevent high blood pressure and heart disease, sometimes labelled "silent killers". Current data stated that one in four people in Indonesia suffers from hypertension (Samiadi, 2020) and that is the fifth leading cause of death in the country (Maryana et al., 2021).

In fact, the circulatory system is one of the topics that is considered difficult for student to learn. In studying this topic, students experience difficulties because it involves complex biological processes and understanding abstract concepts about what happens in the circulatory system (Nurfitriah, 2023). This complex biological system relies on a solid foundation of basic concepts. Students who have misconceptions about the structure and function of system organ as heart, blood vessels, and blood can struggle to learn more complex concepts like blood circulation, blood pressure, and cardiovascular diseases. To reduce the impact, diagnostic tools to stop the cycle of misunderstanding and foster a more accurate and strong understanding base have been developed.

The existing body of research specifically addressing misconceptions related to the circulatory system remains limited. To comprehensively understand the current state of knowledge in this area, a bibliometric analysis using tools like Harzing's Publish or Perish (PoP) and visualization software such as VOSviewer was conducted. Bibliometric analysis serves as a valuable tool for researchers seeking to map the evolution of a research area and uncover potential knowledge gaps. Bibliometric analysis is a systematic review method that searches for research trends and recent issues based on publication history to gain an overview of a research area and produces results by conducting more in-depth content analysis (Nandiyanto et al., 2023).

assess misconceptions on the topic of the circulatory system has also been carried out and developed. This development is used to correct deficiencies in previous diagnostic instruments.

The use of interview to assess the misconceptions has been carried out on the circulatory system. In its use, apart from the time it takes to implement it, interview inefficiencies have been found in research which used the open-ended questions and interview. It that shows that interview results are influenced by teachers' teaching method, so they cannot detect true misconceptions (Izza et al., 2021). As a solution, interview can be conducted as an additional or follow-up instrument from the results obtained to get deeper and more accurate information. The open-ended research conducted on this topic also states that the instruments used are ineffective in time and have a very simple prevalence compared to other data sources, so that the misconceptions seen are only based on the number of existing samples (Pelaez et al., 2005).

To reduce the inefficiency of time use, diagnostic tests seek the use of multiple-choice questions and several tier diagnostic tests. In general, the tier diagnostic test is related to the use of reason in answering questions. In addition, the combination of using tier diagnostic tests using multiple-choice questions is also widely done. Such as in the development of a two-tier test to reduce measurement errors for the chance of students answering correctly at random, with a solution for assessing scientific knowledge on all correct answers (Tüysüz, 2009; Vitharana, 2021). As the solution, then three-tier diagnostic test was developed by adding the confidence level in the third test. This confidence level can make researchers get deeper information and can map students' understanding, namely understanding concepts, guessing, not understanding, and misconceptions (Wahyuni, 2022).

Through three-tier diagnostic test and with help of interview instrument on eleventh grade students, it was found that the percentage of students in the category of misconceptions and lack of knowledge was greater than the percentage of scientific knowledge, such blood plasma whose role is reversed to erythrocytes, where plasma is supposed to transport nutrients and erythrocytes transport oxygen, and blood cells that play a role in the body's defense process are platelets, which actually leukocytes also play

a role (Wahyuni et al., 2020). Unfortunately, the use of an overarching level of confidence made the assessment ambiguous, as it was not possible to see which tier of confidence a student had, so the development continued with a four-tier diagnostic test.

The four-tier diagnostic test is a development of the three-tier diagnostic test by adding confidence levels to each answer and reason. With each level of confidence in the tier, the mapping of student understanding is more easily detected and accurate (Syarafina et al., 2020). It is also used to reveal misconceptions in detail by preventing students from speculating (Fakhriyah & Masfuah, 2021). A preliminary study is conducted as an initial investigative stage in a research project to obtain data to understand the scale of the field of study. After conducting a preliminary study, this test was then developed into a four-tier diagnostic test with multiple choice form to help students focus their answers and avoid students answering randomly so that they are more effective in analyzing data. The questions used in this instrument were developed from learning resources in the form of the Independent Curriculum national package book which has seven concepts to represent topics.

1.2 Research Problem

Referring to the background, the research problem is stated as “How can a Four-Tier Diagnostic Test be used to assess student misconceptions about the human circulatory system?” Based on research problem given, the research leads to describe the following questions:

- a. How do student conceptions about the human circulatory system based on the analysis of a four-tier diagnostic test?
- b. In which questions do students experience high percentage of misconception?

1.3 Operational Definition

1. Four-Tier Diagnostic Test

The four-tier diagnostic test is a test expanded from the three-tier diagnostic test which is used to measure students' understanding of a concept. This test consists of scientific question in first tier, scientific reason of question in third tier, and the confidence level in second tier and fourth tier. This instrument was developed from preliminary study to the

form of multiple-choices question in the first and third tier which four options already provided. And the samples only could give the answer “sure” or “not sure” for the confidence level in second and fourth tier. The analyses were conducted statistically to measure and determine the five of the student conceptions categories.

2. Student Conceptions in Human Circulatory System

Student conceptions are the understandings that students have about a particular concept or subject. The human circulatory system is given to eight grade students in the first semester. This topic discusses the structure and function of the system organs, including related diseases. The *Kurikulum Merdeka* textbook for students was used as the reference. The seven concepts used are heart, blood vessels, blood, atherosclerosis and heart attack, stroke, hypertension, and how to maintain a healthy circulatory organ.

The five categories of student conceptions are scientific knowledge, false positive, false negative, misconception, and lack of knowledge. The scientific knowledge refers to the condition when a student can answer the question confidently with the appropriate reason. False positive and false negative refers to conditions when students confidently answer, but they have an inappropriate answer either in first tier or third tier. Misconception refers to student conceptions which are inappropriate with the scientific questions and scientific reason, either in the first tier or third tier. Lack of knowledge refers to condition when students are not confident in answering either the first tier or third tier, or even both tiers.

1.4 Limitation of Research

This research is limited by several aspects to focus the topic:

a. Human Circulatory System

The research is intended for only students who are already learnt the topic in that was taken from the national curriculum, namely *Kurikulum Merdeka* with seven representative concepts as stated in operational definition.

b. Four-Tier Diagnostic Test

The Four-Tier Diagnostic Test is chosen to diagnose students’ answer misconceptions. It is taken from the generalization of the answer in open-ended questions which is firstly used as preliminary study. Then the multiple-choice questions were made and developed as the representatives of each concept.

1.5 Research Objective

The objectives of this research are described as follow:

- a. To determine the level of student conceptions in learning human circulatory system quantitatively based on the percentage of students result of the four-tier diagnostic test.
- b. To analyse in the detail the concepts that students experience misconceptions in learning human circulatory system topic quantitatively.

1.6 Research Benefit

- a. For Students

The results of this research can help students overcome misconceptions and errors contained in the topic so that the impact is not sustainable. In addition, with several factors diagnosed as causes of misconceptions, students are expected to be more aware and able to find ways to avoid them, so that students can understand the topic according to what they should.

- b. For Teacher

The results of this research are useful for teachers as they can be used as evaluation material and initial reference for teachers in preparing and implementing the teaching and learning process, so that students are able to gain a good and correct understanding of the material on the human circulatory system. Teachers can also improve their professionalism as educators by understanding students' abilities, so that teachers can improve their performance, such as by reducing errors that can cause misconceptions, increasing student understanding, and increasing student motivation in learning. Another advantage is that teachers are able to develop learning strategies and test instruments that are appropriate to use according to students' needs.

- c. For Further Researcher

This research can be used to help provide data that can be used as a reference and add insight for further researchers to improve the quality of research, especially in studying the topic of the circulatory system.

1.7 Organizational Structure of Research Paper

To make this research systematically structured, this research is arranged based on the arrangement below:

a. Chapter I Introduction

This chapter is determined as the foundation of the research. This chapter consists of research background, research problem, operational definition, limitation of research, research objective, research benefit, and the organizational structure of research paper.

b. Chapter II Literature Review

This chapter consists of the theories that are used in this research as literature review. The literature review describes the four-tier diagnostic test, misconceptions, and human circulatory system.

c. Chapter III Research Methodology

This chapter describes how the research was carried out. This chapter consists of research design, participants, research instruments, research procedure, and data analysis.

d. Chapter IV Result and Discussion

This chapter describes the findings during the research. This chapter consists of the answer from the research problem to discover the results of the data analysis.

e. Chapter V Conclusion, Implication and Recommendation

This chapter summarizes the findings and discussion to answer the research problem has determined in Chapter I. This chapter consists of conclusion, implication, and recommendation of the research.