CHAPTER I

INTRODUCTION

1.1 Background

According to a study by Driver and Easley (1978), the existence of Alternative Conceptions hinders students' comprehension of a particular subject. Failure to recognize and tackle these Alternative Conceptions can significantly affect their understanding of the topic and subsequently impact their learning outcomes. This observation aligns with the constructivist learning approach, which emphasizes the importance of addressing students' preconceived notions. Unsurprisingly, the investigation of Alternative Conceptions has become a prominent area of research in science education. Recognizing that students' grasp of specific scientific concepts holds greater significance than their inherent cognitive abilities, numerous researchers have explored Alternative Conceptions related to various scientific topics across different educational levels.

Misconception, as highlighted by Kirbulut & Geban (2014), Gurcay & Gulbas (2015), and Widiyatmoko & Shimizu (2018), stands out as a significant factor that affects students' grasp of physics concepts and can lead to varied interpretations of scientific principles. As per the findings by Kamilah & Suwarna (2016), Ling (2017), and Tumanggor et al. (2019), misconceptions arise in students' minds when they grapple with the problem-solving process and try to assimilate new information into their cognitive frameworks, often due to their imperfect reasoning abilities. According to Gurel et al. (2017) and Hermita et al. (2017), misconceptions can impede the process of integrating newly acquired knowledge following learning, underscoring the need for their prompt identification. Recognizing and pinpointing misconceptions have become crucial steps in fostering an in-depth understanding of students' learning. The detection of misconceptions necessitates the use of suitable tools and instruments to unveil students' conceptual comprehension accurately.

As noted by Narjaikaew (2013: 252), students who have previously struggled to connect their prior experiences with new concepts in Science Learning may be prone to developing misconceptions. Furthermore, Korkmaz et al. (2018) highlighted the emergence of two-, three-, and four-tiered misconception diagnostic tests in recent years. Initially, two-tier tests were introduced as the earliest examples. In a two-tier test, the first tier assesses content knowledge, while the second tier focuses on reasoning. However, these tests do not incorporate a confidence level as part of their design. Three-tier tests are designed to identify misconceptions by evaluating students' responses in multiple tiers. According to Kutluay (2005), a student is considered to have misconceptions if they make errors in either the first or second tier and also express confidence in their answer in the third tier.

However, it is important to acknowledge that three-tier tests come with both advantages and disadvantages. One limitation is the ambiguity regarding the source of the student's confidence in the third tier. It remains unclear whether the confidence stems from their answer in the first tier, the reason provided in the second tier, or both, as pointed out by Kaltakci and Didis (2007). To address the limitations of three-tier tests, the use of four-tier tests has emerged as a solution for uncovering students' conceptions more effectively. In a four-tier test, the first tier focuses on the content and aims to describe the respondents' knowledge. Following that, the second tier assesses the respondents' confidence in their response to the content tier. The third-tier entails providing a reason that supports the answer to the main question. Finally, the fourth tier of the test assesses the respondents' confidence in their response to the third tier (Kaltakci 2012). This comprehensive approach of four-tier tests provides a more detailed understanding of students' conceptions by incorporating the assessment of confidence at multiple stages.

Physics, as a fundamental science, seeks to understand and explain natural phenomena by delving into the underlying concepts behind their occurrences. Numerous studies have been conducted to explore students' perceptions of various phenomena. However, research conducted by Sutopo (2016) revealed that students' perceptions often diverge from accurate scientific knowledge. Specifically, mechanical waves emerge as a physics topic that poses challenges for teacher candidates. Notably, even after learning about mechanical waves, a significant percentage of students, as indicated by some researchers, retained misconceptions. For instance, it was found that 34% of students continued to harbor misconceptions regarding mechanical waves, while 17.94% of students still held misconceptions even after participating in physics lessons with interactive demonstrations. These findings emphasize the persistence of misconceptions and highlight the importance of targeted interventions in addressing them effectively. In addition to the aforementioned studies, Sutopo (2016) and Somroob and Wattanakasiwich (2017) further noted that students commonly hold incorrect intuitions regarding the relationship between amplitude and frequency. They also face challenges in accurately representing the displacement-to-time graph. Moreover, students often encounter difficulties in grasping fundamental wave propagation concepts, including the mathematical representations of general properties of moving waves, understanding the movement of medium particles when traversed by waves, and comprehending the relationship between wavelength, velocity, and frequency. These concepts present significant challenges for students in their journey to develop a comprehensive understanding of wave phenomena.

According to Tongchai et al. (2011), mechanical waves possess certain properties that deviate from common intuition, rendering them challenging to comprehend. Around 80% of high school students tend to make guesses rather than accurately understand these properties. Furthermore, approximately 50% of physics education students experience misconceptions regarding mechanical waves, as highlighted by Caleon and Subramaniam (2010). Additionally, more than 10% of students confidently identify these misconceptions, indicating a notable level of confidence in their incorrect understanding. These statistics emphasize the prevalence of misconceptions and the need for targeted interventions to rectify them. Through research efforts, a four-tier test with confidence levels for both answers and reasons has been developed as a diagnostic tool. This test format involves multiple tiers to evaluate students' understanding. In particular, Nurhidayatullah and Prodjosantoso (2018) mentioned the four-tier test as one type of multi-tier multiple-choice diagnostic test. Multiple-choice tests are generally easier to administer and evaluate, making them a practical choice for assessing students' knowledge and misconceptions in a structured manner. The role of teacher candidates in education is crucial, particularly when it comes to producing competent physics teachers. In the context of educational research, a significant task revolves around identifying students' misconceptions related to physics education. This study aims to serve as a valuable resource for lecturers, teachers, and researchers by pinpointing the specific sub-topics within mechanical and light waves that harbor the most misconceptions. By identifying these areas of misconception, educators and researchers can channel their efforts into addressing and rectifying these misconceptions, thereby enhancing the quality of physics education.

1.2 Research Problem

The research problem of this study is "How do the students understand related to the content of Mechanical and Light Waves, do they have the same reasoning with the scientific knowledge?"

1. What are the levels of student understanding about mechanical and light waves?
2. What misconceptions do the students have about these topics?

1.3 Research Objective

Elaborating on the research problem, this research attempts to explore the following questions.

1. To analyze the level of students' conceptions about mechanical and light waves.
2. To analyze some of the misconception's students have about wave properties and behavior concepts.

1.4 Operational Definition

To ensure clarity and prevent misconceptions, it is essential to provide operational definitions for key terminologies used in the research. By explicitly defining these terms, researchers can establish a common understanding among readers and ensure accurate interpretation of the study's findings. The operational definitions for the terminologies in this research are as follows:

1. Four-tier diagnostic test

The four-tier test encompasses four distinct levels of questions. The first level delves into cognitive knowledge, the second assesses the confidence in answering cognitive questions, the third level probes into reasoning ability, and the fourth level evaluates the confidence in providing reasoning-based answers. This diagnostic test serves as the tool to categorize the conceptual levels, resulting in classifications such as Scientific Knowledge (SK), False Positive (FP), False Negative (FN), Misconception (M), and Lack of Knowledge (LK).

2. Misconception

In this research, misconceptions refer to the inaccurate or incomplete understandings that students hold regarding specific concepts related to the topic under investigation. These misconceptions may arise from preconceived notions, prior experiences, or incorrect information. Misconception is the term used to express a student's understanding of a certain topic that is not in line with scientific knowledge, this is somehow applied if the student itself did not aware of the misunderstanding itself, or the student is not lacking knowledge about the topic discussed. In this research, misconceptions refer to the inaccurate or incomplete understandings that students hold regarding specific concepts related to the topic under investigation. These misconceptions may arise from preconceived notions, prior experiences, or incorrect information.

3. Mechanical and Light Waves

Mechanical and Light waves are topics that present in junior high school or secondary level books, the topic consist of Wave, Vibration, Electromagnetic Wave, Light Wave, and Sound Wave.

By providing these operational definitions, the research aims to ensure that readers have a clear understanding of the terminologies used throughout the study, minimizing the potential for confusion or misconceptions.

1.5 Limitation of Problem

To make the research more focused, the problem is limited as follows:

1. Conceptual mastery (students' understanding) that is measured in this research involves the level cognitive of remembering (C1), understanding (C2), applying (C3), and analyzing (C4) based on Bloom (2012).
2. The scientific concepts explored in this study encompass Waves Behavior and Wave Properties. These topics were selected to investigate and shed light on scientific discoveries related to these specific areas.
3. Four-Tier Test, the limitation of the question, reasoning, and confidence level is that the confidence level and reasoning cannot determine whether the students answered by chance or not.

1.6 Organizational Structure of Research Paper

Chapter I: Introduction

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

Chapter II: Literature Review

This chapter presents a literature review of important variables, including students' conceptions, misconceptions, the four-tier 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 provides an exposition of the data analysis outcomes, accompanied by a comprehensive discussion rooted in the derived results. The content within this chapter directly engages with the research questions, offering insights and interpretations in response to the study's research question.

Chapter V: Conclusion, Implication and Recommendations

This chapter offers conclusions derived from the combined results and discussions. It also outlines implications and provides recommendations for future research directions.

1.7 Research Benefit

This research holds significant benefits for various stakeholders. Teachers can gain valuable insights into students' potential misconceptions regarding scientific knowledge, enabling them to tailor their teaching methods for better comprehension. Students stand to benefit from an enhanced learning experience, reducing the likelihood of misconceptions in the complex topics of Mechanical and Light Waves. Furthermore, this research serves as a valuable resource for fellow researchers, offering insights and avenues for improving and expanding upon the current findings, ultimately contributing to the advancement of knowledge in this field.