CHAPTER I
INTRODUCTION

1.1 Background

Students' conception has become a very interesting topic to be studied. As a progressive research topic, there are a lot of researches had been done and a lot more to come (Neidorf, Arora, Erberber, Mai, & Tsokodayi, 2020). Students' conception is defined as the way students making sense of a range of natural phenomena (Taber & Akpan, Science Education, 2017). It could be ideas, explanations, or reasons on what is happening and what would happen related to natural phenomena. Students get their conception from their intuition and experiences (Lin, 2015). Those experiences are not limited to formal learning but also their experiences when they are out of school such as television that affects students' conception of science (Donovan & Venville, 2012).

Students' experiences out of school are also the source of students' conception. This means that when students come to the class for lessons, they had constructed some of their conceptions already. The conceptions that students have before class is called students' preconception (Chiu, Guo, & Treagust, 2007) (Vosniadoua & Skopelitic, 2017). When students' conceptions are not in line with scientific facts, those conceptions are defined as misconceptions (Neidorf, Arora, Erberber, Mai, & Tsokodayi, 2020). It is a wrong concept but students perceive that concept as true. There are a lot of factors resulted in students misconception such as books (King, 2010) (Zajkov, Gegovska-Zajkova, & Mitrevski, 2016), daily experiences, intuition, and family guidance (Lin, 2015).

However, it needs to be noted that students' conceptions are not always incorrect. Sometimes students have conceptions even before class and those conceptions are in line with science facts (Clement, Brown, & Zietsman, 1989). That is why in this research not only misconceptions are diagnosed, but also students' conceptions in general. Diagnosing students' conceptions provides a bigger picture of how students conceptualized the information or knowledge that they received. It also portrays the level of students' understanding. In this research, a misconception is seen as part of students' conceptions.

There are several reasons which support the statement that diagnosing students' conception is essential. The first is that a proper diagnosis leads to more focused teaching (Romine, Schaffer, & Barrow, 2015). It will likely ensure that new learning happens (Slater, Morris, & McKinnon, 2018). Teachers can strengthen students' scientific knowledge by confirming students' correct conception. Besides, diagnosing students' conception also let teachers be aware of students' miconceptions so they can address it in class. It is very important because when teachers neglect students misconceptions, the misconception will likely stay or even get worse (Redhana, Sudria, Hidayat, & Merta, 2017). Identifying students' conception will also give teachers a picture of students' conception and avoid overestimating it (Malleus, Kikas, & Kruus, 2016). Moreover, teachers who know common misconception that students usually have a much higher n-gain compare to teachers who know only the correct conception and it is considered as teachers' pedagogical competence (Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013).

The importance of diagnosing students' misconceptions as part of students' conception is added by the fact that it inhibits science learning (Ozmen, 2004). Misconception also causing resistance to the proposed development and it affects students' decision making (Lee, 2016). It becomes quiete difficult for teachers to lead students to scientific knowledge because the misconception is in the way. Moreover, since students have a misconception, students have an incorrect concept as considerations for their decision-making that leads to bad decisions. Misconception also interferes with students' performance (Sinatra & Heddy, 2013). Students with misconception have lower performance. It is also found that students with misconceptions tend to quit the program they are attending online (Chen, Sonnert, Sadler, Sasselov, & Fredericks, 2019).

With all the bad effects of misconception, researches had been carried out to eliminate it. Researchers tried and are still trying to develop techniques, methods, and strategies to eliminate students' misconceptions. To prove that a particular way is effective to eliminate students' misconceptions, a diagnostic test needs to be done before and after the intervention was done. It has been done in a lot of researches. Some of them are to prove if the use of refutational maps can

facilitate conceptual change in students (Liu & Nesbit, 2018) and whether Predict, Observe, and Explain Strategy could enhance students' conception in hydrostatic pressure and Archimedes law (Berek, Sutopo, & Munzil, 2016).

Previous research also found that courses conducted online resulted in a higher misconception percentage than courses that are conducted offline (Wendt & Rockinson-Szapkiw, 2014). Online learning has been used in Indonesia since 2019 to respond to an emergency related to the Covid-19 global pandemic. Online learning will surely affect students' conception as the previous research suggested. This reason and the reasons stated beforehand become the basis on why this research is essential.

Diagnosing students' conception had been done in Biology, Chemistry, and Physics alike. However, in this study, Light and Optic Topics are chosen considering that it is one of the essential topics at school based on the 2013 National Curriculum. It is also closely related to students' daily life as light is very vital in the process of seeing. Optical instruments are also very often beneficial for students' daily life whether they realize it or not. The topic is also chosen because there are findings that point to the identification of the same misconception over time (Maison, Asrial, Susanti, Effrita, & Tanti, 2021). Those misconceptions had been identified since 1984 (Eaton, Anderson, & Smith, 1984). These fact supports that identifying students' conception in Light and Optic Topics is still essential.

Along with the popularity of students' conception as a research topic, the instruments to diagnose students' conception are also developed by researchers. There are various types of diagnostic instruments such as interviews, open-ended tests, simple multiple-choice, two-tier multiple-choice, three-tier multiple-choice, and four-tier multiple-choice (Soeharto, Csapó, Sarimanah, Dewi, & Sabri, 2019). Each one was developed to overcome drawbacks from the previous types of instruments. With interviews, researchers may get a detailed picture of students' conception (Malleus, Kikas, & Kruus, 2016). However, it takes a lot of time to do the interview. The judgment could also be subjective.

Open-ended tests overcome the time limitation of interviews and gives freedom to students to express their ideas but it is time-consuming. However, lots

of reseach had used this type of instrument. One of them is the diagnosing of students' conception on day and night cycle (Vosniadou & Skopeliti, 2017). Multiple choice test is then used to cover more students in a relatively short time. However, it is considered too soon to decide the incorrect answer as misconceptions as the reason behind students' answers is unknown. This type of instrument had been used to diagnosed students' conception on Redox (Lu, Bi, & Liu, 2018).

A two-tier test is then developed. Each question consists of a main question and reason. However, researchers can not be sure whether students are sure about their answers or just guessing. Then, a three-tier test was developed. In this type of instrument, the confidence level is added. So, besides asking about the main question and the reason behind it students are also asked whether they are sure about their answers. This type of instrument helps to differentiate the lack of knowledge and misconception (Liampa, Malandrakis, Papadopoulou, & Pnevmatikos, 2017). But again, researcher can not be sure whether students' confidence level is for the main question or the reason tier.

To overcome this obstacle, researchers developed a four-tier test. In this test, the confidence level is asked twice, both for the main question and for the reason. So, there are four tiers which are the main question, the confidence level for the main question, reason, and confidence level for the reason. Since each question consists of four tiers, this type of instrument enables researchers to have a better view of students' understanding. The four-tier test instrument is more sensitive and powerful (Caleon & Subramaniam, 2010). There are various types of student's confidence levels. The first is that the confidence level rated from 1 to 6 consists of just guessing, very unconfident, unconfident, confident, very confident, and absolutely confident (Sreenivasulu & Subramaniam, 2013). There ais also a confidence level rated from 1-100 as a score (McClary & Bretz, 2012). Another is rated by two options which are sure and not sure (Kafiyani, Samsudin, & Saepuzaman, 2019) (Fratiwi, Kaniawati, Suhendi, Suyana, & Samsudin, 2017). In this research, a four-tier diagnostic instrument with two options confidence level is used.

Students' conceptions are often being compared in various ways. For instance, it is compared between control groups and experimental groups (Osman, 2017), between aboriginal and urban junior high schools (Kao, 2007), and between students and pre-service science teachers (Korur, 2015) (Lin, 2015). The comparison had also been done related to light and optic topics. Research in 2013 was done to analyze students' conception on light propagation and visibility of objects. It includes 1,233 Korean students and 1,149 Singaporean students. Using contextualized two-tier test, students' conception of 7-9 grade students from both countries are analyzed. This research also investigated whether or not grades, student achievements, teaching approach, and education system were predictive variables. The result shows that there is no significant difference among grades (Chu & Treagust, 2014).

From the reasons elaborated above, this research will try to diagnose and compare students' conception on Light and Optic Topics with the four-tier test. This research will also talk about the misconception identified. However, several things will be different in this research. The first is that the topic chosen will be broader. In the previous research, the topics chosen were light propagation and visibility of objects. In this research, other characteristics of light will be included as well as optical instruments such as mirrors, lenses, and microscopes. The instruments are also different. In this research, a four-tier test will be used. The last is that in this research students will be grouped into students who have and have not learnt the light and optic topics instead of grade.

1.2 Research Problem

From the elaborative explanation, the research problem can be stated as "How is the diagnosis of students' conception on light and optic topics with the four-tier test?".

1.3 Research Question

Several research questions are derived from the research problem to be investigated. The research questions are listed below.

1. How is the conception of students who have learnt Light and Optic Topics compared to students who have not learnt the topics?

2. What are significant misconceptions of students who have learnt Light and Optic Topics and students who have not learnt the topics?

1.4 Limitation of Research

To make the research more focused, students' conception will be diagnosed without considering how the topics were delivered to students. This research will not taking learning model, learning method, and learning media into account.

1.5 Research Objective

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

1. To describe the conception of students who have learnt Light and Optic Topics compared to students who have not learnt the topics.
2. To describe the significant misconceptions identified in this research.

1.6 Research Benefit

1. Teacher

   This research is beneficial for teachers by providing them common students' conception on light and optic topics. This information gives teachers a view on what level is students' conception on the topics nowadays. This is very helpful especially when teachers don't have sufficient time to do a diagnostic test on their students before conducting the lesson. When teachers do have sufficient time, they can also use the instrument to do a pre-test on students before the lesson. By doing this, teachers can carry out a better learning process that accommodates students' needs according to the result of the pre-test given.

2. Students

   This study is beneficial for students by providing them with information about conceptions on light and optic topics. This can be taken into consideration when students want to improve their knowledge and to understand the topic better. By knowing conception on this particular topic, students can reflect on their conception and make plans for their future studies. They can address the common misconceptions that are found in this research and try to avoid them while trying to strengthen their scientific knowledge.

3. Other Researchers

This study is beneficial for researchers by providing them further materials and data on how to diagnose students' conception on Light and optic topics. This research can also be used as a reference for future research related to diagnosing students' conceptions on other topics. Moreover, the result of this research urges future researches that aim to increase students' scientific knowledge and eliminate students' misconception.

1.7 Organizational Structure of Research Paper

This paper consists of five chapters. The structure is elaborated below.

1. Chapter I: Introduction

   This chapter contains the research background, research problem, research objective, research benefit, and the the organizational structure of research paper.

2. Chapter II: Literature Review

   This chapter contains a literature review of the variables that are considered important. Those variables are students' conception, four-tier diagnostic tests, and light and optic topics.

3. Chapter III: Research Methodology

   This chapter explains how the research will be carried out. It explains the research design, research method, population sample, research intruments, instruments analysis, data collection, technique, and research procedure.

4. Chapter IV: Result and Discussion

   This chapter contains the result of the data analysis. It also contains a discussion that is constructed based on the result. The result and discussion in this chapter are meant to answer the research questions.

5. Chapter V: Conclusion and Recommendation

   This chapter contains the conclusion drawn from the result and discussion. It also contains implications and recommendations for future research.