CHAPTER I
INTRODUCTION

1.1 Background

Education is a crucial factor in enhancing the quality of human resources, serving as the driving force behind a nation's advancement. In the context of rapid scientific and technological advancement, it is imperative to implement transformative changes in the education system to produce students who are equipped to compete on a global scale. This is consistent with the four pillars of education, namely learning to know, learning to do, learning to live together, and learning to be yourself. The importance of 21st century skills in higher education is highlighted, as it promotes lifelong learning and prepares students for challenges in various environments. These skills are in line with the four pillars of education and emphasize adaptability to enhance digital literacy and communication skills (Long et al., 2024). The objective of science education is to equip students with science literacy that extends beyond mere content comprehension to encompass practical skills applicable in everyday life (Cholifah & Novita, 2022). In this context, science education, particularly chemistry education, plays a pivotal role in establishing a robust foundation of scientific literacy (Natural Science) in students. The concepts inherent to chemistry are intimately intertwined with numerous facets of daily life, thus serving as a cornerstone for subsequent learning (Harahap & Novita, 2020).

Chemistry is a subject that requires an understanding of abstract concepts and the capacity for in-depth problem-solving. Chemistry education at the secondary tier necessitates that students engage in active learning, both independently and with guidance from educators. Moreover, chemistry is the scientific study of the properties of matter, its structure, and the changes that occur in matter. These are often abstract and hierarchical in nature (Fadhilah et al., 2020). Consequently, a thorough comprehension of fundamental chemical principles is a crucial element in facilitating students' ability to integrate and relate disparate concepts they have previously encountered with those they are currently being taught. In the course of their learning, students will naturally construct their own concepts based on their existing understand

and construct their own concepts based on their existing understanding. Furthermore, discrepancies in students' capacity to receive and process information can result in misinterpretations. If such misunderstandings are not promptly identified and rectified, they can impede the acquisition of subsequent concepts (Hidayat et al., 2020).

The teaching of abstract chemical concepts can be challenging due to the presence of student misconceptions, which are misunderstandings that do not align with the scientific concepts being taught. A misconception of one concept may have an adverse effect on the subsequent understanding of related concepts. It is incumbent upon educators to address student misconceptions, distinguishing them from mere lack of comprehension. Misconceptions are the result of a lack of comprehension of the underlying concepts, rather than a consequence of a lack of knowledge. Educators often encounter difficulties in identifying and addressing these misconceptions, a challenge further compounded by a lack of clarity regarding the underlying causes (Damsi & Suyanto, 2023).

A common source of misunderstanding in chemical concepts is the concept of reaction rates. The material on reaction rates is perceived as challenging due to its inherent abstract nature and its interconnection with the concept of chemical equilibrium. Furthermore, the limited comprehension of this subject matter among students can be attributed to several underlying factors. Primarily, students' ability to analyse and interconnect various concepts remains underdeveloped. Additionally, students tend to adopt a memorization-based learning approach, which, when coupled with the teacher's exclusive focus on calculation exercises, frequently results in the formation of misconceptions pertaining to the subject (Mualifah & Rahayu, 2023).

In a study conducted by Rumapea & Silaban (2022) on student comprehension of reaction rate material in chemistry, it was found that 35% of students showed understanding of the concept, while 40% displayed misconceptions and 25% lacked conceptual understanding. Another study by Khairunnisa & Sudrajat (2023) investigated student misconceptions in various sub-concepts of reaction rate. The results indicated that there were misconceptions in 46.75% of students regarding reaction order and reaction rate equation, 33.33% in the concept of collision theory, 22.91% in understanding the basic concepts of reaction rate, and 20.27% in grasping the concept of factors affecting reaction rate. These findings highlight the prevalence of misconceptions among students in chemistry, particularly in the understanding of reaction rate concepts and sub-concepts (Khairunnisa & Sudrajat, 2023; Rumapea & Silaban, 2022).

Teachers are concerned about students' chemistry misconceptions as they hinder learning progress. To address this issue, teachers should use evaluation questions to measure students' understanding. Diagnostic instruments like tests can help identify misconceptions and act as remediation tools. These instruments analyze students' understanding, including their reasoning abilities and confidence in their answers. Diagnostic tests also allow teachers to gain insight into students' thought processes, even if their answers are incorrect. Administering these tests before learning helps teachers understand students' initial conceptions and tailor teaching strategies accordingly. Furthermore, diagnostic tests conducted after learning provide an overview of students' achievement tiers. By utilizing diagnostic tests, teachers can address misconceptions more effectively and facilitate better learning outcomes in chemistry (Damsi & Suyanto, 2023).

A variety of diagnostic tests have been developed, spanning from two-tier tests to five-tier tests in the format of multiple choice. The results of the analysis of student misconceptions using a two-tier diagnostic test indicated that 62% of students demonstrated an understanding of the concept, 23% exhibited misconceptions, and 15% displayed a lack of understanding of the basic laws of chemistry (Lahinda & Tuerah, 2022). Two-tier diagnostic tests are constrained in their ability to differentiate between a lack of conceptual understanding and misconceptions, but unable to distinguish between accurate understanding and guesswork.

Three-tier diagnostic test was introduced to address these limitations that incorporating an additional dimension of students' confidence in their responses, that enables teachers to differentiate between students who lack conceptual understanding and those who hold misconceptions, thereby facilitating the development of more effective teaching strategies. The results of the research on the analysis of student misconceptions using the three-tier diagnostic test indicate that 31.85% of the students demonstrated overall conceptual understanding, while 49.86% exhibited moderate criteria for misconception. The remaining 18.29% of students demonstrated a lack of understanding of the concept, exhibiting low criteria for reaction rate material

(Fadhillah, 2024). However, the test also has inherent limitations in measuring confidence, given that answers and reasons are assessed concurrently.

Four-tier diagnostic test was devised, that permits students to gauge their confidence in their answers and reasons, thus enabling educators to identify misconceptions with greater precision, but the test remains unable to accommodate randomly selected answers or guesswork (Inggit et al., 2021). The results of the analysis of student misconceptions using the four-tier diagnostic test indicate that 35% of students demonstrate an understanding of the overall concept, 53% exhibit moderate misconceptions, and 12% lack comprehension of the concept in regard to reaction rate material (Safputry, 2024).

Diagnostic tests are useful for identifying misconceptions in students. However, these tests have limitations in determining whether errors are due to lack of knowledge or misconceptions. The five-tier diagnostic test was developed to address this issue by offering a more comprehensive form of assessment. This test consists of five parts: a multiple-choice question, confidence in the answer, reason for choosing the answer, confidence in the reason, and an open-ended question. The open-ended question allows students to provide explanations, drawing of conclusions, and other forms of testing that are relevant to the specific requirements of the question. By including these components, the five-tier diagnostic test provides a more accurate insight into student understanding, reducing the likelihood of arbitrary answers or guessing. Educators can use these tests to diagnose misconceptions more effectively, adapt learning strategies based on student needs, and ensure a focused learning process that targets reducing these misconceptions (Fajriyyah & Ermawati, 2020).

The results of research on the identification of misconceptions experienced by students using a five tier diagnostic test instrument on the concept of reaction rate conducted by (Mualifah & Rahayu, 2023) showed that students experienced misconceptions in the sub-concept of reaction rate by 26, 67%, the sub-concept of collision theory by 63.34%, the sub-concept of the effect of temperature on the reaction rate by 57.78%, the sub-concept of catalyst and activation energy by 12.21%, the sub-concept of reaction order by 18.90%, the sub-concept of preventing physical and chemical changes by 26.66% The factors that cause students' misconceptions come from preconceptions, low basic abilities of students, students' interest in learning the concept of reaction rate, and students' learning sources from the internet.

A five-tier multiple-choice diagnostic test for chemistry is a useful tool for identifying student misconceptions about reaction rates, but it has not been widely used in education. Educators can create a comprehensive five-level diagnostic test by utilizing Microsoft Forms that offers several benefits. Microsoft Forms is a web-based application that allows users to create and share tests, quizzes, and surveys. The test can be accessed from various devices and operating systems, enabling students to take the test online or in a blended learning environment. Integration with Microsoft Excel facilitates quick data analysis, helping educators identify answer patterns and areas of misunderstanding. The user-friendly interface of Microsoft Forms enhances student engagement and concentration during the test. The application offers multiple-choice, short-answer, and rating scale features that can be effectively used to develop a comprehensive diagnostic test instrument. Forms and quizzes are separate icons within Microsoft Forms, allowing users to choose the appropriate option for their needs. The form's accessibility can be set to a specific time frame, and students can access the form link without needing an account. An automatic grading feature eliminates the need for manual grading by teachers. However, it is important to note that a stable internet connection is required to use Microsoft Forms effectively (Ardian et al., 2020).

The results of initial observation interviews with chemistry teachers at SMA Negeri 5 Medan showed that the curriculum currently used in grade XI is the Merdeka curriculum which includes reaction rate material. Reaction rate material is one of the subjects that causes misconceptions among students. The causes of these misconceptions include learning methods that tend to be lectures which prioritize the role of teachers and the lack of student involvement in the learning process. In addition, teachers also often do not comprehensively understand the causes of these misconceptions which can be influenced by various factors such as lack of student interest in learning which causes students to lack focus during learning, low student abilities, learning methods applied, and learning resources and teaching materials used. Interviews with open questions were also conducted with grade XI students. Students stated that when learning chemistry, especially on reaction rate material, teachers only use textbooks as the only reference source and still use conventional learning methods, namely lectures, so that students often experience misconceptions in understanding the concept of reaction rate. Identification of misconceptions using diagnostic tests five-tier, or even one-tier that online-based, has not been carried out by teachers because teachers are less aware of student misconceptions based on the level of student involvement in the learning process and student misconceptions that are reflected in their academic achievement.

In light of the aforementioned issues, the researcher is interested in conducting a study entitled "Analysis of Student Misconceptions Using Five-Tier Diagnostic Test on Reaction Rate Material at State Senior High School 5 in Medan during the 2024/2025 academic year."

1.2 Problem Identification

In consideration of the aforementioned background, the following issues have been identified:

1) The misunderstandings encountered by students in the context of reaction rate material can be attributed to two principal factors: an inadequate and insufficiently comprehensive approach to the subject matter and a dearth of advanced conceptual understanding among students. Furthermore, students who have developed their own understanding of the concept of reaction rate based on their prior knowledge may also be responsible for the prevalence of these misconceptions.
2) The inability of educators to identify and address misconceptions in a comprehensive manner hinders their ability to differentiate between students who are genuinely struggling to comprehend a concept and those who are merely experiencing misconceptions.
3) Teachers have not utilized test instruments to identify the misconceptions experienced by students on the reaction rate material, particularly five-tier diagnostic tests, during the learning process.

1.3 Scope of Study

In light of the aforementioned background and the problem identification, the aim of this study is to conduct a more detailed analysis of the five-tier multiple-choice diagnostic test on the topic of reaction rates, which has been assisted by Microsoft Form. This study will focus on class XI students at SMA Negeri 5 Medan, with the aim of identifying any misconceptions that may be present. The study was conducted during the 2024/2025 academic year.

1.4 Problem Limitations

In order to facilitate a comprehensive and focused discussion of the identified problem, the researcher has limited the scope of the existing problems as follows:

1) The material under consideration in this study is the reaction rate.
2) The study was conducted on a sample of class XI students from SMA Negeri 5 Medan, who had previously studied the reaction rate material.
3) An analysis of the misconceptions of students who had studied the reaction rate material was conducted using a five-tier multiple-choice diagnostic test instrument assisted by the Microsoft Form application.

1.5 Problem Formulation

In light of the aforementioned constraints and identification of the problem, the following formulation of the problem is proposed for consideration in this study:

1) How the feasibility from material and media experts of five-tier multiple choice diagnostic test instrument that assisted by Microsoft Form in identifying misconceptions among class XI students on the reaction rate material considered expert validity tests in aspects of material, construction, and language?
2) How did the results of the product testing instrument test assisted by Microsoft Form for reaction rate material administered to class XI students through of the validity, reliability, difficulty tier, discriminatory power, and distraction tests?
3) What is the percentage of misconceptions experienced by class XI students on the reaction rate material using the five-tier multiple choice diagnostic test instrument?

1.6 Research Objectives

In consideration of the manner in which the problem has been framed and the context that has previously been elucidated, the following constitute the study's primary objectives:

1) Ascertain the feasibility from material and media experts of five-tier multiple choice diagnostic test instrument that assisted by Microsoft Form in identifying misconceptions among class XI students on the reaction rate material considered expert validity tests in aspects of material, construction, and language.
2) Find out the results of the product testing instrument test assisted by Microsoft Form for reaction rate material administered to class XI students through of the validity, reliability, difficulty tier, discriminatory power, and distraction tests.
3) Knowing the percentage of misconceptions experienced by class XI students on the reaction rate material using the five-tier multiple choice diagnostic test instrument assisted by Microsoft Form.

1.7 Research Benefits

In accordance with the findings of the research project, the anticipated advantages of this research are as follows:

1) Theoretical Benefits

   It is anticipated that this research will prove instrumental in the advancement of educational methodologies, particularly those pertaining to the discipline of chemistry, as a means of evaluating the efficacy of learning processes. Theoretically, the results of this study are expected to serve as a reference for the development of science, specifically in regard to the creation of a five-tier diagnostic test on the reaction rate material for class XI SMA/MA. The test is to be developed as a valid and suitable instrument for use in learning. Moreover, it is anticipated that the findings will contribute to the reduction of misconceptions and enhance students' scientific abilities in the field of reaction rate material.

2) Practical Benefits

a) For Students

The five-tier multiple-choice diagnostic test is designed to address the specific needs of students, allowing them to identify potential misconceptions related to the reaction rate material and enhance their understanding in accordance with the correct conceptual framework.

b) For Educators

This instrument can serve as a valuable reference for educators seeking to refine their teaching methods, with the aim of reducing misconceptions and fostering deeper student comprehension of the reaction rate material. This innovative teaching material can be used as an alternative in the chemistry learning process, particularly in relation to the concept of reaction rate.

c) For schools

The results of this study can be used as a reference or test instrument material to reduce misconceptions in chemistry learning, particularly in relation to the reaction rate material experienced by students.