CHAPTER I

INTRODUCTION

1.1 Background

Education is a process that runs consciously and is structured in building a learning atmosphere and learning activities that can develop the potential that exists in students in an active and fun way so that students not only gain knowledge in science but also in religious spiritual values, self-control, personality and skills needed in every side of life. Education includes all learning experiences carried out throughout life in all environments and situations that play a role and provide positive meaning in the growth of each individual (Pristiwanti et al., 2022).

Education as the foundation for students' intellectual development and analytical abilities. Where the aim is to equip students with in-depth knowledge and understanding in various scientific disciplines, one of which is chemistry. Learning chemistry at the high school level is one of the subjects that plays a role in developing students' scientific understanding. The scope of chemical studies is divided into concepts that are visible to the eye and some that are abstract. These two characteristics make learning chemistry tend to be difficult. In an effort to help students understand quite complex chemical concepts, students are expected to be able to master three interrelated levels of chemical representation, namely at the macroscopic level which shows real and visible phenomena such as chemical reactions, submicroscopic levels such as atoms or structures that are not visible, as well as symbolic levels such as representation symbols, formulas or equations (Hu et al., 2022).

One of the materials in learning chemistry that requires a deep understanding of the three levels of chemical representation is the concept of Acid-Base. Acid-base is one of the topics in chemistry subjects which discusses several sub-topics, including the concept of acid-base properties, the development of acid-base theory, the strength of acids-bases and neutralization reactions. In studying acid-base material, students are expected to be able to master other chemical concepts

such as the concept of chemical equilibrium, chemical reactions, stoichiometry, and the properties of matter and solutions. The topic of acids and bases is conceptual, calculating and abstract, so effective learning strategies are needed so that they can provide experience and practice that can develop the development of students' competencies. However, the problem that generally occurs is that learning devices or teaching materials are still inadequate so that they cannot support students in deepening their knowledge, the nature of solving the problems they face, their experience in learning and building students' activeness. Based on this, tools are needed that can provide support during the learning process in the form of facilities and devices to support students' learning activities (Lestari et al., 2021).

The limited availability of learning devices has a big influence on the quality of learning and the extent to which students can understand the material being studied. The limited use of learning tools such as learning media can have an impact on not achieving understanding of the concept of acids and bases in the three levels of chemical representation which can give rise to misconceptions in students. One example is in learning about the concept of acid strength, students are expected to be able to explain the difference in the dissociation ability between strong acids and weak acids through lamp flame experiments with electrolyte tests at the macroscopic level, then to show the differences in the level of dissociation of the two compounds at the sub-microscopic level and can write dissociation reaction equations at the symbolic level (Amry et al., 2022).

Several previous studies have shown that there are still many students who experience difficulties and misconceptions about several basic concepts of acid-base material. When learning acids and bases, students cannot deepen the material because most students have difficulty understanding the concept and calculation of pH (Supatmi et al., 2019). Students tend to only memorize examples of strong acids and weak acids without understanding that the strength of the acid is determined by the degree of ionization, so they assume that the strength of the acid-base is determined by the concentration of the solution. In addition, students have difficulty understanding the relationship between hydrogen ion concentration and pH (Ivanoska & Stojanovska, 2021). Students are still limited in

understanding at the microscopic level which also hinders students' ability to solve problems on macroscopic and symbolic representations (Susilaningsih et al., 2020). So that the use of appropriate learning media and learning models can support the achievement of learning objectives and provide a very necessary representation of chemistry.

Based on observations made at SMA Negeri 1 Habinsaran, it shows that the learning media used in the Acid-Base learning process is still focused on teaching materials that are less interesting, less innovative, and are only limited to textbooks provided by the school. Based on the analysis of the syllabus and lesson plans in **Appendix 1** and **Appendix 2**, students are expected to be able to analyze the properties of solutions based on the acid-base concept both theoretically and practically. However, the use of media that supports achieving this goal has not been fulfilled. The use of learning media is generally not sufficient to support project learning activities or discovery learning as well as learning activities that are not yet supported by practicum implementation so that the learning activities carried out are still teacher-centered. The use of learning media that is less interesting, less innovative and limited can make learning activities tend to be monotonous, less interactive and students lose interest in understanding concepts, making it difficult for students to internalize acid-base material properly. Therefore, an innovative approach is needed that is able to overcome these problems.

One method used to build an active learning atmosphere in learning is the application of innovative learning. Learning innovation emphasizes its benefits in simplifying the learning process, increasing students' ability to remember the information they have learned, and building more effective and efficient learning activities (Nainggolan et al., 2020). The application of innovation in chemistry learning is expected to improve learning outcomes and student competence (Pakpahan et al., 2022). Learning innovations in studying acids and bases are expected to contain material with an attractive appearance and provide space to carry out simple experiments with the application of acids and bases in everyday life and can demonstrate the three levels of representation in chemistry.

The teaching method using PhET virtual laboratory-based learning media is one innovation that provides interactive simulations in understanding chemical concepts. Learning with the help of virtual laboratories can make learning more interesting which can increase students' motivation in participating in learning (Yakob et al., 2023). PhET simulation media helps students carry out experiments and observations to understand the material, this simulation media presents visualizations of the forms of each material found in everyday life so that students will be actively involved in learning, observing, conducting experiments, and drawing conclusions based on the data that has been obtained. (Haryadi & Pujiastuti, 2020). The choice of using PhET simulation media is based on the interaction simulation capabilities of PhET which supports the involvement of three levels of chemical representation through animation and connects the integration of the three levels in the chemistry learning process (Salame & Makki, 2021).

Based on the explanation above, the use of PhET virtual laboratory-based learning media in Acid-Base learning is the right and optimal choice to help guide students in understanding the material. By implementing this innovative approach, it is hoped that students will not only be able to understand the concept of acids and bases in depth, but also students will be more interested in learning acids and bases in a more interactive and effective way. With the virtual experiment and interaction features in the simulation, students have the opportunity to pay attention to changes that occur in acid-base solutions, understand the concept of pH, and can visualize the structure and processes of acid-base solutions down to the microscopic level. The application of this learning media helps students build a solid conceptual understanding, reducing the possibility of misconceptions between concepts (Rahmawati et al., 2022).

Based on this description and various opinions in previous research, the researcher wants to develop and implement PhET virtual laboratory-based learning media with the title ”**Implementation of PhET Virtual Laboratory-Based Learning Media to Increase Learning Outcomes on The Teaching of Acid-Base”.**

1.2 Problem Identification

The problems that can be identified are as follows:

1. Chemistry learning at SMA Negeri 5 Medan, SMA Negeri 1 Habinsaran and SMA Negeri 1 Borbor especially in Acid-Base material, is still done in theory.
2. Lack of teaching materials that can improve student learning outcomes.
3. Lack of virtual laboratory-based learning media on acid-base topics at SMA Negeri 5 Medan, SMA Negeri 1 Habinsaran and SMA Negeri 1 Borbor Utilization of technological developments in media that contains theory and practice in chemistry learning.

1.3 Scopes of Research

Based on the problem identification that has been stated, the researcher defines the problem so that the research more focused:

1. This research will be given to students of class XI MIPA at SMA Negeri 5 Medan, SMA Negeri 1 Habinsaran and SMA Negeri 1 Borbor, the material is limited to Acid-Base material in Chemistry subject.
2. Development of learning media only on the topic of Acid-Base.
3. Learning media made by researchers themselves and assisted with PhET virtual laboratories on Acid-Base material.
4. This research focuses on applying the Project-Based learning model with a virtual laboratory to improve students' learning outcomes in Acid-Base.

1.4 Problem Limitations

Based on the Scopes of this research, the limited problems are:

1. This research was conducted on the 2013 Curriculum.
2. Subjects in this study were class XI MIPA in the 2023/2024 academic year at SMA Negeri 5 Medan, SMA Negeri 1 Habinsaran and SMA Negeri 1 Borbor.
3. The material focuses on the topic of Acid-Base.
4. The learning model used is Project-Based Learning (PjBL).

1.5 Problems Formulations

The formulations of the problems obtained are:

1. How is the feasibility of PhET virtual laboratory-based learning media according to BSNP standards?
2. How students' teaching and learning activities when implementing the developed PhET Virtual Laboratory-based learning media for the teaching of acid-base?
3. How effective is the developed a PhET Virtual Laboratory-based learning media on improving student learning outcomes in the teaching of Acid-Base?

1.6 Research Objectives

Based on the problem formulation above, the objectives of this study are:

1. To develop a PhET Virtual Laboratory-Based Learning Media for the teaching of Acid-Base.
2. To standardize a developed PhET Virtual Laboratory-Based Learning media in order to meet the feasibility criteria for teaching materials according to BSNP standard.
3. To investigate students' teaching and learning activities when implementing the developed PhEt virtual laboratory-based learning media for the teaching of acid-base.
4. To investigate the effectivity of a developed PhET Virtual Laboratory-Based Learning Media on improving student learning outcomes in the teaching of Acid-Base

1.7 Research Benefits

From the results of this research, it is hoped that it will provide good benefits to all parties. The benefits of this research will consist of 2 parts, namely theoretical or academic benefits and practical benefits. For benefits in the theoretical or academic field, the results of this research will be one of the latest innovations in teaching material, especially in the topic of teaching Acid-Base. For benefits in the practical field, the results of this research will help researchers as teachers in the future to better understand and apply technology in creating learning media as well as hone and train the skills of future researchers to follow

the current development of industry 4.0. This institution can serve as an alternative learning and information medium in teaching Acid-Base material.