# CHAPTER I
# INTRODUCTION

## 1.1. Background of the Problem

The chemistry education curriculum in Universitas Negeri Medan refers to the draft curriculum concept based on the KKNI with the aim that the graduates of Chemistry Education prospective teachers can have superior and quality competence, be productive, capable and skilled in managing the learning process with full responsibility in the application of their competencies in the world of work as a professional teachers after becoming alumni (Harahap et al., 2021). As candidates for chemistry teachers, students of the Chemistry Education Study Program, FMIPA, Universitas Negeri Medan are also required to be able to conduct ICT-based research. This is in line with one of the missions of the Chemistry Education Study Program, FMIPA, Universitas Negeri Medan, which is to develop the Chemistry Education Study Program into superior and has character based on ICT and the Industrial Revolution 4.0 platform, and future developments that are beneficial to the development of science and technology and society.

Along with the advancement of science and technology, educators also need to be more innovative in order to improve the learning process, one of which is inventing new learning materials. When there are not enough educators of sufficient quality and quantity, the need for learning materials grows. Teachers are required to completely consult textbooks when planning, carrying out, and assessing learning. The accessibility of learning material is crucial for providing students in universities and schools with high-quality education (Sary et al., 2018).

One of the elements that helps students, both those in schools and those in universities, obtain knowledge or comprehension is the availability of learning materials. Students' individual study is given priority during the university learning process. It is not sufficient for students to merely rely on lecturers' explanations in order to understand a subject (Sary et al., 2018). One type of the teaching materials that can be used by students in universities is electronic module (e-modules). E-module is designed to be used by students independently, because it contains instructions for self-study.

Learning modules are deliberately designed for use by students without the presence of lecturers (Rahmi, Ibrahim, & Kusumawardani, 2021). The advantage of e-modules over printed textbooks is that they contain video, audsio and animation as well as other interactive functions that students can view and then play back. Innovative assessment is given to e-modules because they can be interactive learning companion materials that are also complete and interesting and have good cognitive meaning (R. A. Putri & Andromeda, 2022).

One of the required disciplines in the faculty of mathematics and natural sciences is chemistry, a subject that is full of abstract ideas (Sary et al., 2018). There are various ways of teaching chemistry such as projects, field trips, expositions, experimental and guided discovery strategies. These methods rely on various forms of teacher-student activities (Adarkwah & Amenorfe, 2022). In the most traditional procedures, teaching relies primarily on passive-student lectures with algorithmic-problem exams. Occasionally, scripted lab classes follow theoretical titration lectures, where students have the chance to practice their observational skills and make links between theory and practice (Supasorn, 2012).

The 21st century learning focuses on four skills (4C) that must be mastered by students namely communication, critical thinking, collaboration, and creativity (Febri et al., 2019). Students are required to think critically in connecting new concepts with previous learning. Students are capable of building incorrect connection to previous learning that are invalid or the foundations of which are faulty (Hakim et al., 2016). In the course of Analytical Chemistry there are several basic materials, one of which is Acid-Base Titration. Titration is a basic concept for learning analytical chemistry (Widarti et al., 2017). Some students considered that if the material is one of the subjects in basic analytical chemistry courses that are considered difficult (Situmorang et al., 2015).

A needs analysis was carried out for lecturer supporting the Analytical Chemistry course in the Chemistry Education 2021 at Universitas Negeri Medan. Based on Appendix 5, the supporting lecturers also have not used a virtual laboratory in teaching acid-base titrations and design all practicum activities. Learning acid-base titration can be done using a learning e-module integrated with

virtual laboratory because according to Copriady & Linda (2019) learning with a virtual laboratory can improve generic science skill, logical infers ability, and concept building ability better. In addition of the six indicators of critical thinking skills according to George Brown College, students can only make and explain conclusions well. So, students' critical thinking skills must be improved to be better in understanding a topic or deciding on a course of action (Saleem & Masadeh, 2021).

Before carrying out the practicum, Chemistry Education students class of 2021 at Universitas Negeri Medan had been taught the theory of acid-base titration material in class. Then, students are given a pre-test to find out students' initial understanding before conducting experiments in the laboratory. However, after the practicum is completed, students are rarely given a post-test to find out students' final understanding after conducting experiments in the laboratory so that students' critical thinking skills have not been measured either.

Student need analysis was carried out on students of the Chemistry Education study program class of 2021. Based on Appendix 6, only 17.1% of students have used virtual laboratories to conduct experiments. We can find various types of virtual laboratories on the internet in the form of applications and websites. One of the benefits of using a virtual laboratory is that students can collect data quickly in any situation (Z. S. Putri & Kurniawati, 2021). All respondents needed alternative teaching materials that could be used to learn the concept of acid-base titration more easily and interestingly so that 95.1% of students agreed that teaching materials such as an e-module integrated with virtual laboratory were needed to improve critical thinking skills on acid-base titration materials. 39% of students admitted that they had difficulty learning acid-base titration material from the practicum manual, the reasons included the completeness of the material, explanation techniques, and format. Research conducted related to the e-module integrated with a virtual laboratory on acid-base titration material is research conducted by R. A. Putri and Andromeda (2022) which shows the validity and practicality of the developed e-module has very high validity.

The analysis of Semester Learning Plan on acid base titration material is carried out. Based on Appendix 1, students are required to be able to choose the right indicator, calculate the pH, predict the equivalence point, and explain the titration curve. This shows that students must first understand the basic concept of titration. Students need critical thinking skills to make it easier for students to understand the basic concept of titration. When students are able to do the indicator points in the table, it will be easier for them to think critically.

Although laboratory activities are very important, in their implementation there are still various obstacles such as preparation and implementation of practicum requiring a long time (Khaeruman et al., 2017). 92.7% of respondents in the student needs analysis questionnaire agreed that currently they have time constraints in carrying out practicums of acid base titration. With the development of information and communication technology, the virtual laboratory as an alternative way to resolve the issue (Widowati et al., 2017). The benefits that can be obtained are that the learning process becomes more interesting, more interactive, the amount of teaching time can be reduced, the quality of learning can be improved and the teaching and learning process can be carried out anywhere and anytime (Nirwana, 2011). The use of virtual laboratory is also proven to improve students' thinking skills (Widowati et al., 2017).

Based on observations in the Chemistry Education Study Program at Universitas Negeri Medan, the use of e-module integrated with virtual laboratory used in Analytical Chemistry teaching, especially the topic of Acid-Base Titration, is very rare. However, what is commonly used is only practical guidebook of Analytical Chemistry. The practicum module is useful as a guideline for practicum activities that can support and facilitate students when carrying out practicum activities. As an alternative, e-module integrated with virtual laboratory is offered to learn Acid-Base Titration which can be studied anytime and anywhere. The e-module integrated with virtual laboratory contains practicum guideline, so students are expected to understand the concept of titration better so that it can be applied the same as in actual titrations in the laboratory. Based on the discussion above, the researcher wants to examine the "**Development of E-module Integrated with**

**Virtual Laboratory on Acid-Base Titration Material to Improve Critical Thinking Skills**".

### 1.2. Problem Identification

The problems that can be identified are as follows:

1. Indonesian students' critical thinking skills are still low.
2. Lack of teaching materials that can help students' critical thinking skills.
3. Lack of availability of e-modules that are integrated with virtual laboratories on the topic of Acid-Base Titration at Universitas Negeri Medan.
4. Utilization of science and technology in teaching materials that contain theory and practice in learning chemistry.

### 1.3. Scope of Research

Limitations in this study are as follows:

1. The developed e-module is only on the topic of Acid-Base Titration.
2. E-module developed for Acid-Base Titration topic including experiments.
3. The e-module developed in this study is accompanied by questions to measure students' critical thinking skills.
4. The application used to conduct virtual practicum is the Praxilabs as virtual laboratory website.

### 1.4. Formulation of the Problem

The formulation of the problem obtained:

1. What are the stages to be carried out to design an e-module integrated with virtual laboratory to improve student critical thinking skills on the teaching of acid-base titration?
2. How is the strategy carried out to standardize an e-module integrated with virtual laboratory of acid-base titration in order to meet the feasibility criteria for teaching material according to BSNP standards?
3. How are the students' teaching and learning activities when implementing of the e-module integrated with virtual laboratory for the teaching of acid-base titration?

4. How good are students' critical thinking skills after taught by using an e-module integrated with virtual laboratory in the teaching of acid-base titration?

### 1.5. Research Objectives

The objectives of this research are:

1. To design an e-module integrated with virtual laboratory to improve student critical thinking skills on the teaching of acid-base titration.
2. To standardize an e-module integrated with virtual laboratory of acid-base titration in order to meet the feasibility criteria for teaching material according to BSNP standards.
3. To investigate students' teaching and learning activities when implementing the e-module integrated with virtual laboratory for the teaching of Acid-Base Titration.
4. To investigate students' critical thinking skills when implementing the e-module integrated with virtual laboratory in the teaching of acid-base titration.

### 1.6 Benefits of Research

The benefits in this research are:

1. For students, it can be a learning resource to better understand, add insight, and improve critical thinking skills in Acid-Base Titration material using e-module integrated with virtual laboratory.
2. For lecturers or laboratory assistants, it can be used as additional or alternative teaching materials that can be used in the learning process, especially during distance learning.
3. For researchers, it can add insight in developing an e-module integrated with virtual laboratory and add knowledge to researchers as prospective teachers to develop creative and innovative teaching materials.