

CHAPTER I

INTRODUCTION

1.1 Background of the Study

The current coronavirus pandemic (COVID-19) has disrupted research and education. Laboratory closures have had a significant impact on traditional laboratory-based disciplines such as biochemistry and molecular biology. Hundreds of practical sessions in academia have been suspended globally in 2020/2021 with no clear indications. A difficult situation that is causing severe stress and anxiety in the academic community. Experiments are an important part of science because they allow students to gain valuable experience in a variety of techniques while also developing the skills required for future jobs in industry and academia. As a result, virtual laboratories are now being used to teach biology, chemistry, and natural sciences (Vasiliadou, 2020).

A virtual laboratory is a platform that contains simulated and remotely triggered laboratory experiments, allowing students to learn scientific concepts governing the experiment easily through visualization and practice (Jones, 2018). There are free virtual laboratories available for many basic science subjects, including physics, chemistry, and biology (de Jong and Marcia, 2013). From simple videos and games to graphing and 2D simulations, virtual laboratory experiences can range from simple to interactive 3D virtual reality experiences. Simulations, which are mathematical models of physical processes, allow users to manipulate parameters and can be used by faculty to customize laboratories in a variety of disciplines, including virtual dissections, chemical reactions, and laws of motion experiments (Welsch, 2015).

A virtual laboratory has several benefits: it promotes teamwork, is low in cost, promotes active learning, allows students to learn at their own pace and in their environment, fosters creativity, reduces the fear of failure or making mistakes, may provide a more learner-centered approach, may increase student engagement, and may foster autonomous learning. It also overcomes health and safety concerns and allows the teacher to conduct laboratory activities without leaving the classroom (Climent-Bellido *et al.* 2003; Chan and Fok, 2009; Cobb *et al.* 2009; de

Jong and Marcia, 2013; Jensen and Kromann, 2013; Bortnik *et al.* 2017). Another benefit of learning using virtual laboratory media is to train self-efficacy, attitudes, and motivation (Dyrberg *et al.* 2016), and also improve knowledge competence, one of which is procedural knowledge (Widiantini *et al.* 2017).

Anderson & Krathwohl (2001) define procedural knowledge as the "knowledge of how" to do something. The "something" could range from simple exercises to the solution of novel problems. Procedural knowledge is frequently expressed as a series or sequence of steps to be taken. It includes knowledge of skills, algorithms, techniques, and methods, which are referred to collectively as procedures. Computer-based simulations for scientific learning can be used to facilitate both procedural knowledge to perform experimental procedures and conceptual knowledge to understand and explain demonstrations. However, further research is needed on the educational effects of the simulated scientific environment (Honey & Hilton, 2011).

Several studies have been conducted to investigate the effect of virtual environments on students' self-efficacy (Wilde and Hsu, 2019). It was discovered that the virtual laboratory was more effective at improving difficult concepts and self-efficacy in scientific inquiry. Ghergulescu *et al.* (2019) created a personalized interactive for students. In conjunction with the physical laboratory, the virtual laboratory significantly increased students' self-efficacy for microbiology experiments (Makransky *et al.* 2016). After conducting experiments in the virtual laboratory, students' learning gains, student engagement, self-efficacy, motivation, and achievement improved. The virtual laboratory also assisted teachers in improving their understanding and confidence in teaching science. (Bautista and Boone, 2015).

Experiments in the laboratory are inseparable from the curriculum and lead to the research on self-efficacy in the experimental environment. In addition, self-efficacy theory supports the emphasis on self-efficacy in the experimental environment. "Experimental self-efficacy" (ESE) is defined as a belief in the ability to successfully perform actions and observations in experimental settings in a controlled manner to achieve results. This requires a complete understanding and

implementation of the experimental procedure to achieve the experimental results (Kolil *et al.* 2020).

Virtual laboratory in genetics is limited to molecular biology courses such as DNA extraction and PCR (Alvarez, 2021). DNA extraction is the process of separating DNA from cell membranes, proteins, and other cellular components from a sample using physical and/or chemical methods. DNA must first be separated from the remaining cellular components and existing non-biological material. Removes foreign substances after cell lysis, reducing sample (DNA) degradation caused by cellular enzymes, while ensuring maximum enzymatic efficiency during the typing process (McClintock, 2014). According to Yunus & Syam (2021), an application is needed as an interesting way to teach molecular biology courses to students to help the understanding process. This is because the material studied in molecular biology is considered sufficiently complex and complicated.

The research result of initial observations conducted through a questionnaire on a Google form in the Biology Education Study Program of 2019 in a virtual experiment shows that 35% of the total respondents have never carried out experiment activities through a virtual laboratory. The virtual laboratory in the DNA extraction experiment is intended to help students understand the material better. Based on questionnaires conducted by students of the biology education study program, 60% agree that virtual experiment is better used than direct experiment during the current pandemic (COVID-19). As many as 75% of students will feel more confident and understand more about the DNA extraction experiment which will be carried out through a virtual laboratory.

This research focuses only on questions related to the use of can influence students' procedural knowledge and self-efficacy on DNA extraction experiment in the biology education study program at Universitas Negeri Medan. Intuitively, students must have a high level of procedural knowledge and self-efficacy for a successful experiment. Measuring students' procedural knowledge and self-efficacy is an important improvement to get good learning outcomes in learning. Therefore, the author conducted research entitled "The Influence of Virtual Laboratory Towards Students' Procedural Knowledge and Self-Efficacy on DNA

Extraction Experiment in the Biology Education Study Program at Universitas Negeri Medan”.

1.2 Problem Identification

Based on the background above, it can be identified the following problems:

1. Students have difficulty while cannot do DNA extraction experiment in the pandemic of coronavirus (COVID-19).
2. Students are worried to have low procedural knowledge because they cannot conduct the experiment on the pandemic of coronavirus (COVID-19).
3. It is worried that passive online learning causes low self-efficacy of students.

1.3 Scope of Study

This research analyze the influence of virtual laboratory towards students' procedural knowledge and self-efficacy on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan. The procedural knowledge indicator in this study are: (1) Knowing the apparatus, tools, and chemical substances that be used in DNA extraction experiment, (2) Knowing the function of the apparatus, tools, and chemical substances that be used in DNA extraction experiment, and (3) Can describe the steps and the principles in DNA extraction experiment. Meanwhile, the indicators of self-efficacy refer to self-efficacy dimensions such as 1) Magnitude/level, 2) Strength, and 3) Generality (Bandura, 1997).

1.4 Scope of Problem

Based on the background and problem identification above, in this research, there is a need for problem limitation so that the assessment of the problem in this research can be more focused. Due to the limitations of the researchers in terms of ability, funding, time, and energy, this research only limits the problem of “The Influence of Virtual Laboratory Towards Students Procedural Knowledge and Self-Efficacy on DNA Extraction Experiment in the Biology Education Study Program at Universitas Negeri Medan”.

1. Research subject

The subject of this research is the student in the biology education study program of 2019 (PSPB E 2019).

2. Object of research

The object of this research is how the use of a virtual laboratory affects students' procedural knowledge and self-efficacy aspect in DNA extraction experiment.

1.5 Research Questions

1. How is the influence of the implementation of virtual laboratory towards students' procedural knowledge on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan?
2. How is the students' improving learning results based on n-gain test after using virtual laboratory on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan?
3. How is the students' self-efficacy when using virtual laboratory on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan?

1.6 Study Objectives

1. To know the influence of the implementation of virtual laboratory towards students' procedural knowledge in the Biology Education Study Program at Universitas Negeri Medan?
2. To know students' improving learning results based on the n-gain test after using virtual laboratory on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan?
3. To know students' self-efficacy when using virtual laboratory on DNA extraction experiment in the Biology Education Study Program at Universitas Negeri Medan?

1.7 Research Benefits

This research is expected to provide benefits for the student, the university, and the researcher.

1. For the student is expected to improve procedural knowledge and self-efficacy through the use of virtual laboratory, especially in DNA extraction experiment.
2. For the university, this result of research expected can be used as input to improve the students' procedural knowledge and self-efficacy, also to develop a virtual laboratory for other courses or experiments.
3. For the researcher in this research, is to know how important procedural knowledge and self-efficacy are in the learning process so that it can improve it again.

1.8 Operational Definition

1. A virtual laboratory (VL) is a computer program that is used to conduct experiments through web simulations or as stand-alone applications that allow students to quickly and easily learn scientific concepts governing the experiment through visualization and practice A virtual laboratory assists a system in running a traditional laboratory.
2. Procedural knowledge is the knowledge of how to carry out a specific skill or task and is related to methods, procedures, or equipment operation. Procedural knowledge is also known as implicit knowledge or know-how.
3. Self-efficacy is a person's belief in his or her own ability to successfully engage in a given behavior, which can influence the activities that people choose to engage in and the amount of effort they put into such activities or achievements.
4. DNA extraction is a technique that uses physical and/or chemical methods to separate DNA from cell membranes, proteins, and other cellular components in a sample. DNA separation techniques should be able to efficiently extract pure, high-quality DNA free of contaminants such as RNA and proteins. During the extraction of DNA, the cells are lysed and the DNA is separated from them.