

Characteristics and Effectiveness of Blended Learning Through Reality Laboratory and Virtual Laboratory Activities in Genetics Course

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ABSTRACT

Virtual laboratories can provide real learning experiences through computer-aided simulations and activities. Virtual laboratory is rapidly developing its use in science learning because it is proven to provide significant benefits to the process and results of science learning during the pandemic. The limitations of laboratory facilities in genetics learning at the unkhair Biology Education Study program have encouraged the development of virtual practicum strategies and their use in genetic learning with modified free inquiry strategies on the topic of the structure and function of genetic material and reproduction of genetic material. The purpose of this study was to analyze the effectiveness of virtual laboratories based on student perceptions of the use of virtual laboratory applications and to describe and compare these perceptions with the use of laboratory reality and relevant previous research results. There are five aspects of perception surveyed, namely innovation, motivation, effectiveness, benefits, and presentation of practical procedures. This research method uses a quasi-experimental research design for the characteristics and effectiveness of using virtual laboratories and real laboratories in the Genetics course at the Biology Education Study Program, Khairun University, Ternate on the topic of DNA isolation, chromosomes and mitosis. The results of this study indicate that: the characteristics of Blended Learning practicum in the Genetics course in 4th semester students of Biology study program are: 1) instruction-based practicum; 2) practicum based on data collection and reporting of practicum results; 3) practicum based on proof of concept. The effectiveness of the implementation of genetics practicum in laboratory reality and virtual laboratories based on the perception of student responses is more likely to choose reality laboratories than virtual laboratories. The effectiveness of the implementation of genetic practicum based on the results of the practicum report is known to be not significantly different between the results of the practicum in reality and in the virtual laboratory.

KEYWORDS

Blended Learning
Reality lab
Virtual lab
Genetics Course

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1. Introduction

Laboratory activities with experimental methods have an important role in learning Genetics. The experimental method is an effective way of learning by including the active role of students in it which is useful in improving memory in learning. The material for isolation of DNA, chromosomes and mitosis in the Genetics lab requires a large number of practical tools and hazardous chemicals, so preparation and discipline are needed in laboratory practice. Various obstacles faced in learning science such as limited laboratory facilities or lack of learning resources and learning media can be overcome with the ability of computer technology.

The study of Genetics requires careful study, discussion, and laboratory procedures of various biological phenomena down to the DNA molecule level. For this reason, learning facilities are needed that support student activities in studying the phenomenon of chemical reactions in these organisms. However, there are still obstacles to the limitations of laboratory facilities in the Unkhair Biology Education Study Program. The alternative solution is to develop a virtual laboratory (virlab) application which is expected to overcome the limitations of laboratory facilities and give students the experience of 'working' in a biology laboratory.

Virlab is an interactive simulation of an experiment in which all manipulations are performed inside a computer (Mas'ud et al., 2019). According to (Mas'ud et al., 2019) virlab is a software that simulates experiments in real laboratories. Virlab has been popularly used in most science learning, mainly because it is supported by increasing computer capabilities in information processing (Mas'ud

et al., 2019). Various virlab applications related to biological content and also virtual biological equipment have been developed and used in learning, for example biotechnology virtual labs (Mas'ud et al., 2019), virtual microscope (Mas'ud et al., 2019), virtual transgenic (Mas'ud et al., 2019), virtual immunology (Mas'ud et al., 2019), virtual morphology laboratory (Avila, et al. , 2013), and in pharmaceutical microbiology and toxicology (Dyrberg, et al., 2016). Most of the virlab software have 3D graphics that can improve the user experience, but the level of detalization of the virlab environment varies (Abramov, et al., 2016). Virlab software products are available on various platforms, including desktop and web-based. Desktop versions generally have better graphics and higher quality content (Raineri, 2001).

The use of virlab has several advantages, namely flexibility in setting the time and location of the practicum, practicum results are immediately available and reliable, practicum can be repeated immediately, there is no need to frequently buy laboratory equipment and materials, experiments are safe and economical because it allows 'work' with hazardous materials or chemicals. expensive, and the duration of the experiment is shorter (Mas'ud et al., 2019); does not depend on the availability of actual experimental facilities, minimal errors in work procedures and experimental handling errors, and also minimal use of reagents (Mas'ud et al., 2019); improve work safety in the laboratory (Mas'ud et al., 2019); and is a more effective way to focus students on understanding difficult concepts (Mas'ud et al., 2019).

The limitations or weaknesses of using virlab in learning are the loss of hands-on skills in working in real laboratories, the lack of connection between the design and experimental results, and the lower level of socialization or collaboration among students (Mas'ud et al., 2019); limited possible actions, poor manual response, and possible lack of proper experience when dealing with real laboratory facilities (Mas'ud et al., 2019).

Various research results have explained the implications of using virlab in science learning, for example, it has the potential to improve pre-laboratory preparation so that students feel much more confident and comfortable operating laboratory equipment, are able to adjust parameters and results, and increase student discussion participation in microbiology and toxicology practicums. pharmacy (Mas'ud et al., 2019); improve the development of concepts and laboratory skills as well as the ability to diagnose disease (Mas'ud et al., 2019); can increase knowledge acquisition and promote effective chemistry learning, can present chemistry teaching materials at macroscopic, symbolic, and submicroscopic levels (Mas'ud et al., 2019). Research (Mas'ud et al., 2019) found a significant increase in the number of students who experienced increased knowledge, confidence, and experience about laboratory techniques after viewing virtual videos, and that instructional videos as pre-laboratory exercises have the potential to standardize techniques and support successful experimental results. This study aims to analyze and test the effectiveness of the virtual laboratory and laboratory reality in learning Genetics courses.

2. Method

This type of research is a quasi-experimental research design posttest-only control design. The research group consisted of two experimental groups, namely the first group was the experimental group which was measured using a learning model using a real laboratory and the second group using a virtual laboratory.

There are two variables in this study, namely the independent variable and the dependent variable. The independent variables are (X1) the use of real laboratories, (X2) the use of virtual laboratories and the dependent variable is (Y) students' perceptions and learning outcomes. The data processing of the research results used two techniques, namely descriptive analysis and inferential analysis using SPSS version 15 software

3. Results and Discussion

The implementation of the Genetics 1 course practicum for 4th semester students in 2021 on the concept of Genetic Materials is carried out in a reality laboratory and a virtual laboratory. The topics of the practicum carried out were DNA isolation of bananas carried out in a laboratory reality; The topic of observing the giant chromosome of the salivary gland *Drosophila melanogaster* was carried out in a virtual laboratory and Observation of the phases of cell division by mitosis was carried out in a virtual laboratory. The description of the implementation of the Genetic 1 course practicum can be seen in the student responses to the implementation of the practicum as follows:

a) Purpose of Practicum

Student responses related to practicum objectives Most students have understood the purpose of practicum, which is to see the structure of DNA (49.3%) and the remaining percentage explains the purpose of techniques and insulation materials. The description of the practicum objectives is as shown in Figure 1 below:

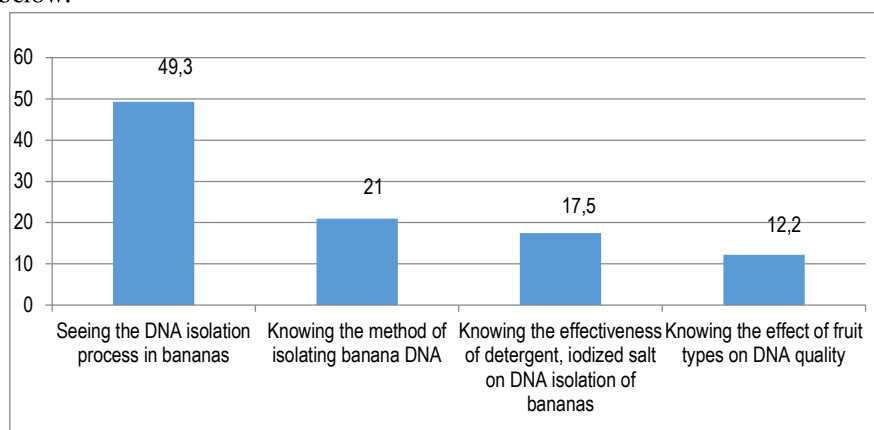


Figure 1: The Purpose of the DNA Isolation Practice

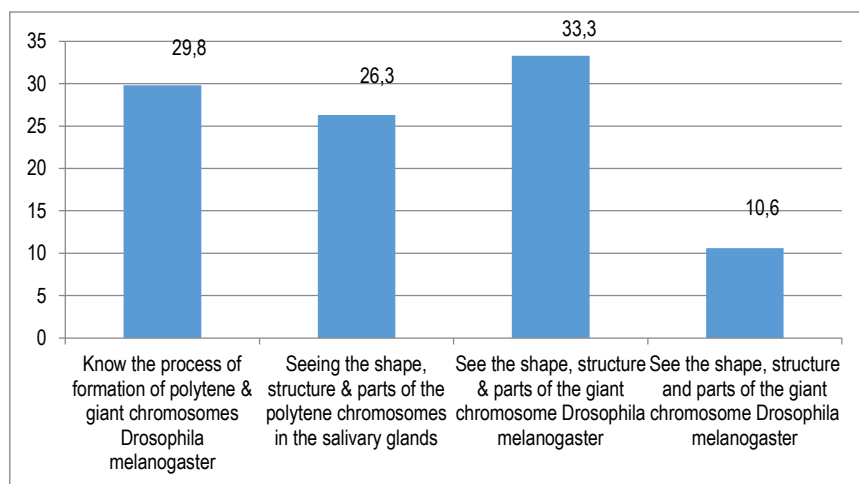


Figure 2. The Purpose of the Giant Chromosome Practicum

Based on the description above, it can be seen that most of the students already know the purpose of the practicum to see the structure and shape of giant chromosomes in the salivary glands of *Drosophila* (33.3%).

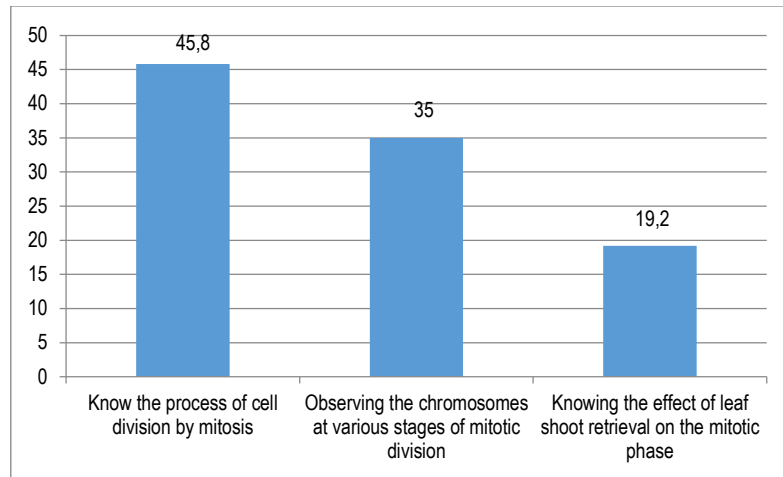


Figure 3. The Purpose of the Ptacticum of Mitosis

Based on Figure 3 above, it is known that as many as 45.8% of students understand the purpose of the red onion root mitosis practicum.

b). Perception of Laboratory reality

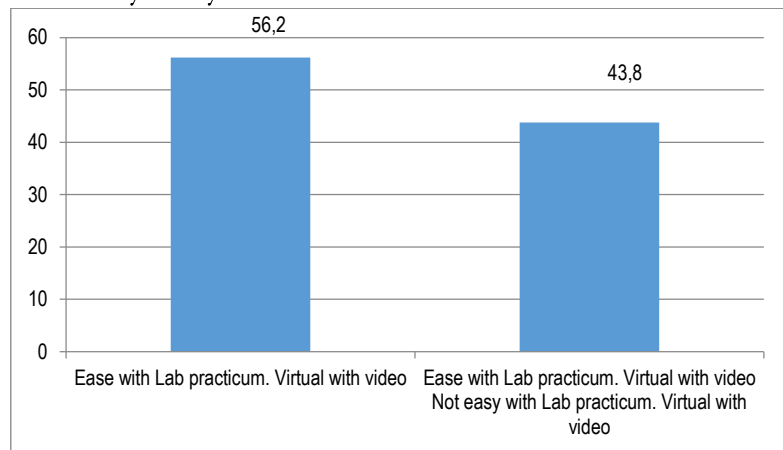


Figure 4: Student Response to Laboratory Reality

It is known that most students tend to find it easier in learning laboratory reality

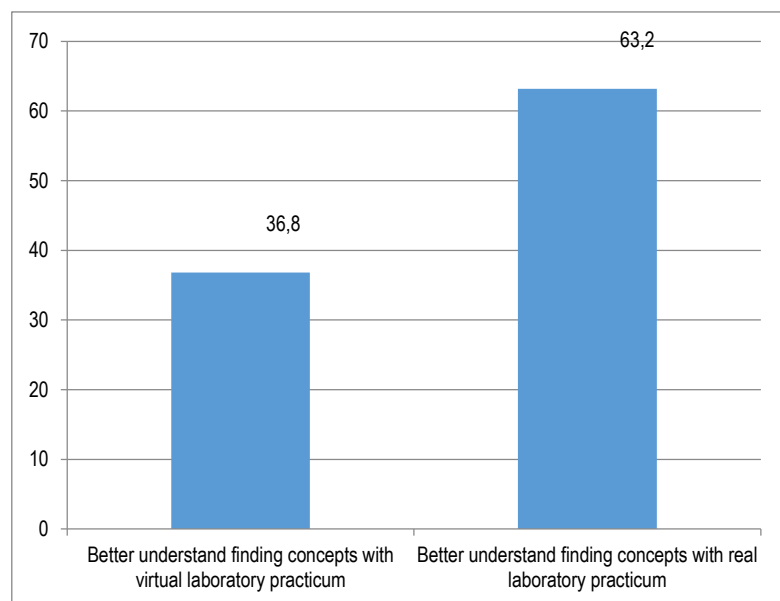


Figure 5: Student Response to Virtual and Reality Lab.

From Figure 5, it is known that most (63.2%) students feel they understand more about the concepts in the reality laboratory practicum

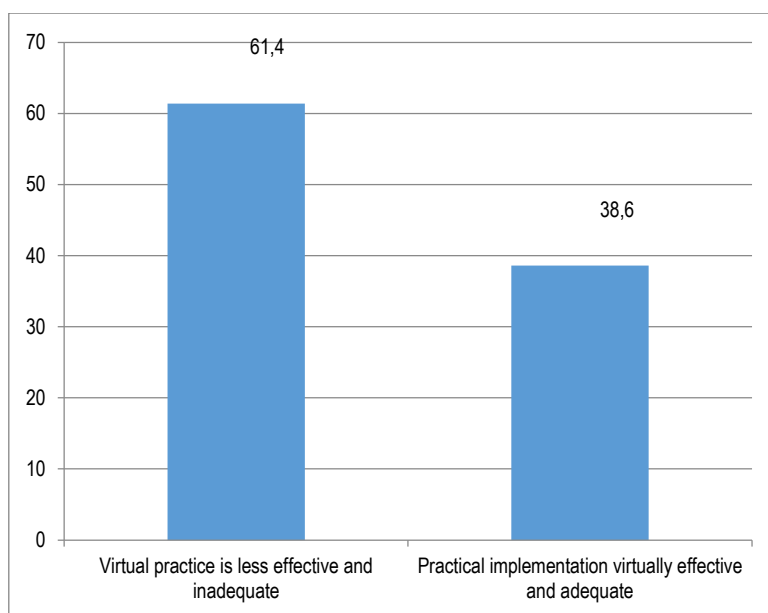


Figure 6: Virtual Lab Implementation Suggestions

Furthermore, from Figure 6, it is known that most (61.4%) provide suggestions for real practicum because the virtual practicum is less effective

c) Hypothesis Test

Hypothesis testing. After calculating the normality test and homogeneity test, the data obtained were normally distributed and homogeneous, then continued with the t-test. Based on this, it will be continued in testing the research hypothesis (H1). From the results of the t-test obtained $t_{count} = 17.416$ and $t_{table} = 2.021$ for $db = 56$ from a significance level of 5%. This means that $t_{count} > t_{table}$, so H_0 is rejected and H_1 is accepted. Based on the testing criteria, H_0 is rejected and H_1 is accepted, which means that there are differences in student learning outcomes who practice virtual and laboratory reality in the Genetics 1 course in the Biology education program at Khairun University in 2021.

The results of this study provide information that semester 4 students of Biology education study program in 2021 generally prefer and feel they understand and are effective in practicum with laboratory reality. This finding is in line with the results of the research by (Mas'ud et al., 2019) which found that of the three types of laboratory work, virlab was the least favored by students. Learning with the surrounding environment as a learning resource provides experience to students and can improve learning outcomes (Nugroho & Hanik, 2015).

Students prefer the computer-supported laboratory (CSL), followed by the traditional laboratory (TL), and finally the virtual laboratory (VL) on yeast activity, gas exchange, and heart rate experiments. Students like laboratory work with computer support (CSL), not just simulation. They prefer CSL because there is a combination of hands-on activities and computer technology so that hands-on skills and digital-computer competencies can develop. Students don't like VL because everything is prepared perfectly, and they just press a button on the computer so that motivation decreases and becomes bored.

The virlab application used in genetics learning is designed to support free inquiry learning, where students must actively seek knowledge and information from various learning sources in order to test the research hypotheses that have been proposed. Therefore, before carrying out virtual practicum activities, students should try to learn the concepts and working procedures of DNA isolation, observing giant chromosomes and mitosis.

The results of data analysis showed that 61.3% of students had positive perceptions and 38.9% had negative perceptions. When compared to other aspects, in this aspect of effectiveness the negative perception of students is the greatest, meaning that quite a lot of students think that virlab is ineffective and inefficient to replace real or real lab practicums.

This negative perception can be related to the report of (Mas'ud et al., 2019) which states that the use of animation does not always function as an effective tool for learning. This statement is reinforced by the results of research by (Mas'ud et al., 2019) that student users do not like virlab because everything has been prepared perfectly, and users only need to press a button on the computer so that users are less motivated and become bored.

Likewise, (Mas'ud et al., 2019) do not recommend virlab as a substitute for hands-on practicum and CSL, but only as a complement for example to introduce new subjects, assist absent students, or to implement expensive, dangerous or impossible experiments. practiced in the school laboratory. However, (Mas'ud et al., 2019) have tested the effectiveness of virlab with a quasi-experimental approach and the test results show that the experimental class that uses virlab in their learning has higher academic achievement than the control class.

4. Conclusion

Virtual laboratories and Reality laboratories are one of the blended learning approaches in practicum during a pandemic. The effectiveness of the implementation of genetics practicum in laboratory reality and virtual laboratories based on the perception of student responses is more likely to choose reality laboratories than virtual laboratories. The effectiveness of the implementation of genetic practicum based on the results of the practicum report is known to be not significantly different between the results of the practicum in reality and in the virtual laboratory. In general, Biology Education students in semester 4 of 2021 who take genetics 1 course are more likely to choose Reality laboratories than virtual laboratories. The aims and practicum methods will be better understood by carrying out a reality laboratory.

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