

Opportunities to Use Virtual Laboratories to Facilitate Biology Learning in High Schools

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Abstract

Technological developments have changed the way students learn, many students prefer to use smartphones to study compared to using books. Learning biology itself is learning that requires students to do a lot of activities so the right method used is a problem-based and experimental learning method. However, schools cannot provide all learning facilities such as practicum equipment. Therefore, teachers can use existing technology such as digital learning media to support learning. This type of research is qualitative de-scriptive research. The focus of the research is 32 student's science majors of grade 2 high school students. Methods of data collection using interviews and using a questionnaire. The analysis was carried out in four stages: data collection, data reduction, data preconcluding conclusions. The results of the study show that there is a great opportunity for conducting experiment-based learning with the help of a smartphone, such as using a virtual labora-tory. As many as 81% of students said that practicum would help them un-derstand biology concepts. Additionally, 94% of students use technology to help them learn. Thus using of virtual laboratories is an opportunity to over-come the lack of learning facilities and can encourage students to be more active in learning activities.

Keywords: *Virtural Laboratory, Learning Biology, Critical Thinking*

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INTRODUCTION

For this new generation, technology has become an integral part of their daily life. Since birth, children have been exposed to various technological tools (Dilekçi & Karatay, 2023; Hett, 2012) They grew up in a world where technological tools and digital applications have become widely used. They use smartphones, computers, and tablets intensively to access and share information (Dilekçi & Karatay, 2023; Duran & Ertan Ozen, 2018; Yang & Wu, 2012). Of course, this changes the paradigm of how they learn. Children who used to use books and teachers as their learning source, now prefer to use technology as their learning resource because they can access it quickly. One of the learning skills that must be possessed in the 21st century is the ability to think critically (Pardede, 2020). By having critical thinking skills, students will question, examine, and evaluate the information obtained. With evaluation activities, one can review the underlying reasons and look for strong evidence to decide whether the information is accurate or not (Orhan & Çeviker Ay, 2022).

In learning biology itself, the ability to think critically is one of the keys to increasing scientific literacy which is the goal of science education (Hiğde & Aktamiş, 2022). This is because critical thinking skills reflect scientific reasoning skills. To improve critical thinking skills, learning should often involve observation, exploration, research, problem-solving, decision-making, information gathering, critical questioning, evaluation, and other activities (Antonia et al., 2022). Learning activities should be able to provide direct experience for students or with experimental-based learning (Jerrim et al., 2022). Based on the results of interviews with high school biology teachers, learning biology that is carried out in class is mainly done conventionally, the teacher only gives material or gives assignments to students. Teachers do not use learning models such as problem-based learning or experimental-based learning. One of the reasons why teachers do not use experiment-based learning is that schools do not have a biology laboratory that can support experiment-based learning.

Based on the problem of lack of school facilities, technology can be used to overcome this problem. Virtual laboratories can be used as an alternative to support experiment-based learning. This virtual practicum environment allows students to design and conduct virtual experiments, process data, and analyze and interpret experimental results (Hartog et al., 2009; Verstege et al., 2019). The virtual laboratory itself is a technology designed to simulate laboratory activities that are as similar as possible to physical/real laboratory activities to provide comparable knowledge and skills to students (Pearson & Kudzai, 2015). This virtual practicum environment can be a rich interactive learning environment where students work on independent learning assignments. Students can design their experiments, answer closed questions, ask for feedback or directions, seek additional information about the material including visual information such as videos, photos, and animations, and process and understand data (Verstege et al., 2019).

There have been many previous studies regarding the use of virtual laboratories in learning. Baris (2021) in his research developed a virtual laboratory application for biology subjects, namely respiration material. Virtual laboratories are an option, especially in teaching abstract subjects that are difficult to understand, such as breathing (Çingil Barış, 2022). Research conducted by Aripin & Suryaningsih (2020) developed a virtual laboratory to improve students' critical thinking skills on the concept of bacteria (Aripin & Suryaningsih, 2020). This research is in line with research conducted by Setya et al. (2021) where virtual laboratories are effective in improving students' critical thinking skills (Setya et al., 2021).

METHODS

The method used in this research is a descriptive qualitative method. Through this research approach, it will identify opportunities for students to use virtual laboratories to support the biology learning process in the digital era and as an alternative solution to the problem of the absence of laboratories in schools in depth. The process was shocked by observing the research needs analysis and conducting interviews with teachers about biology lessons that have been carried out so far. After taking notes, distribute questionnaires to students. Then analyze the results of the questionnaire and present the results of the research desktop. The object of this research is the use of smartphones and experiment-based learning. Data collection methods used are interviews and surveys. Data analysis was carried out using descriptive analysis to see opportunities for virtual laboratory users to support the biology learning process in the digital era and as an alternative to the absence of laboratory rooms in schools.

RESULTS AND DISCUSSIONS

This research was conducted by involving 32 respondents from Kanisius Harapan Tirtomoyo High School, Wonogiri Regency, Central Java Province. The results of the study indicate that there are opportunities to use virtual laboratories in the biology learning process, especially to help students overcome the lack of school facilities due to the absence of adequate laboratories for experiment-based learning. The opportunities that arise cannot be separated from the use of technology and smartphone ownership in students. The large number of students using smartphones can be used to access information and include the use of virtual laboratories in the biology learning process. Smartphone ownership data is presented in Figure 1.

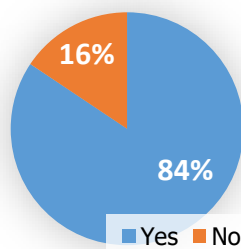


Figure 1. Smartphone Ownership Data

Based on Figure 1, it can be seen that 84% of students have personal smartphones that they use to help students obtain information, communicate, and support them in learning. Most students take advantage of the convenience of technology to support their learning activities as shown in Figure 2.

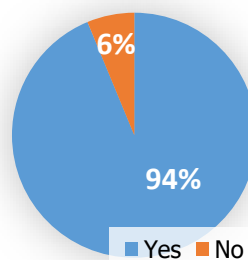


Figure 2. Utilization of technology for learning

Based on Figure 2, it can be seen that 94% of students like to use technology to help them learn. This is because the school allows the use of smartphones, tablets, and laptops in the learning process. Students can easily obtain information via the internet, students can also easily share information about the material they are studying using social media.

The learning methods used by teachers in classroom learning so far are lectures, discussions, demonstrations, and experimental methods. In Figure 3 it can be seen that 69% of students answered that students used the lecture method in learning biology, 58% of students said that the teacher used the discussion method in learning, 18% used the experimental method, and 6% used the demonstration method. This shows that teachers are still dominant in using conventional methods of learning. In Figure 4 it can be seen that the teacher uses PowerPoint media, pictures, videos, teaching aids, and social media in the biology learning process. As many as 31% of students answered that the teacher used PowerPoint media in learning, 59% of students answered that the teacher used picture media in learning biology, 34% of students answered that the teacher used learning videos, 34% of students answered that the teacher used visual aids, and 40% of students answered that teachers use social media in biology learning activities.

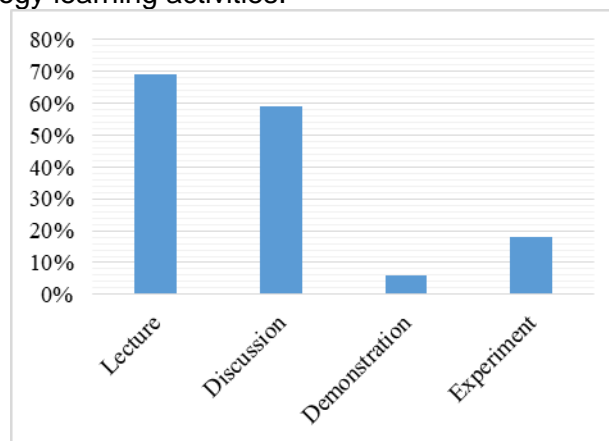


Figure 3. The learning method used by the teacher

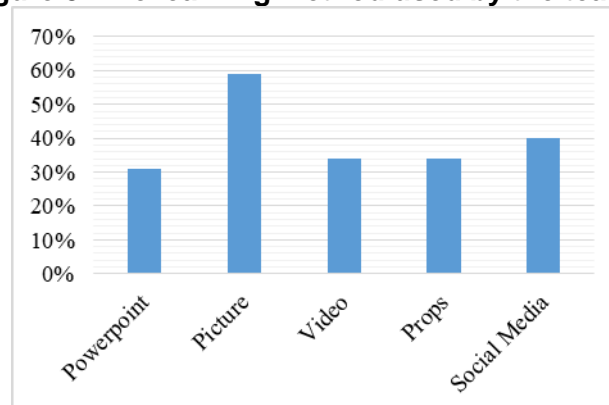


Figure 4. The media used by the teacher

Even so, based on interviews with teachers and questionnaires distributed to students, they have never used virtual laboratories in learning, including learning biology. The data can be seen in Figure 5. In the process of learning biology, teachers usually use smartphones only to share material such as PowerPoint, pictures, and learning videos, or to give assignments to students and students can find answers to assignments given by the teacher via the internet. Teachers have not maximized the use of technology in

supporting the learning process, even though many interactive media can be used to assist biology learning. The Ministry of Education and Culture itself also released a virtual laboratory that contains many virtual laboratories from sharing materials and subjects on the learning house website and can be accessed easily by anyone.

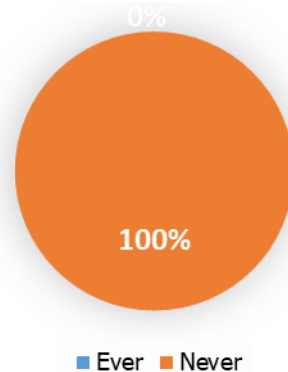


Figure 5. Use of the Virtual Laboratory in Learning

To learn biology concepts on their own, students prefer hands-on practice rather than just reading abstract concepts. Based on Figure 4, it can be seen that as many as 81% of students think that practicum is needed to learn biology concepts. Students can build on the concepts they learn through practicum activities so that they will more easily understand the material than just being explained by the teacher or reading books. In addition, because they build their conceptual understanding, the concepts they build become long-term memory.

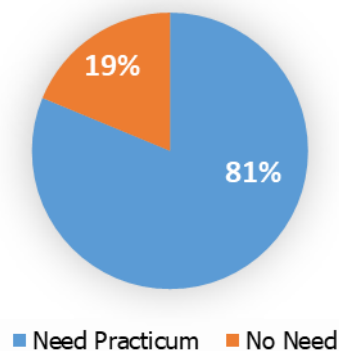


Fig 6. student statements about the need for practicum to learn biology concepts

Biology as part of science has certain characteristics in the learning process. According to Carin & Sund, learning science including biology which is a science contains six elements, namely, the first element is active learning where students are required to be active in learning activities, the second element is the discovery/inquiry approach where learning is carried out in class-based discovery, the third element is scientific literacy where learning is scientific literacy, the fourth element is constructivism where learning allows students to construct their knowledge independently, the fifth element is science, technology, and society where learning uses science and technology to solve problems in everyday life in society, as well as the sixth element of understanding that truth in science is not absolute but tentative (Jayawardana & Gita, 2020). If the elements of science learning are applied in learning, it will be able to improve student's critical thinking skills because the learning process supports students to continue to be active and explore. Students' critical thinking skills can increase if students are involved

in learning planning, asked to solve problems (using problem-based learning models and project-based learning), case studies, oral presentations, direct learning activities (experimental-based learning, simulations), and others (Bezanilla et al., 2019; Seibert, 2021).

The learning environment will affect students' critical thinking skills. Support for the learning environment such as the assistance of technological devices will provide opportunities to explore and facilitate access to information so that students can develop themselves, participate in educational activities, become more confident, can think critically, and keep up with the latest developments. Existing facilities in schools are very important to support the learning experience of students. In addition to the facilities provided by schools and efforts to utilize existing resources for the benefit of students, the quality of teaching staff owned by schools can be said to affect critical thinking skills because the quality of these teachers will help increase students' awareness to participate in activities to improve critical thinking skills (Arslan, 2012).

The results of this study indicate that in learning is mostly conducted with lectures and discussions, and the teacher does several hands-on practices that do not require a laboratory. It can be seen that 69% of students use the lecture method, 58% use the discussion method, 18% use the experimental method and 6% use the demonstration method. The experimental method used by the teacher is an easy practice and does not require a laboratory. The teacher only conducts several lessons using the experimental method due to the absence of laboratory facilities at school.

The absence of laboratory facilities can be overcome by utilizing a virtual laboratory. By utilizing a virtual laboratory students can carry out experiments like in a real laboratory by following the instructions given to them or the instructions on the test sheet. One of the important features that distinguish this type of virtual laboratory from computer-assisted applications is the ability to design experiments suitable for various achievements in science and technology (Çingil Barış, 2022). The virtual laboratory has several advantages, including increasing the accessibility of laboratory activities for students who are hindered by some reason from being able to access the physical laboratory, the virtual laboratory does not experience space requirements constraints like a physical laboratory, low setup and maintenance costs, and a rich virtual laboratory environment. technology can increase the motivation of modern learners (Pearson & Kudzai, 2015). The use of virtual laboratories in learning is of course supported by the habits of students who use technological assistance for learning and high student ownership of smartphones.

Virtual laboratories are considered a new teaching strategy that is cheaper, easier, and can attract students' attention in the learning process. Scenarios used in virtual learning for science teaching have proven to be effective (Shanck, 1997). Virtual laboratory can improve students' critical thinking skills This is because students can do practicum as well as practicum learning in real laboratories, so students are motivated to take part in learning activities and can discover concepts through procedures carried out in virtual laboratory activities(Sukenti, 2021).

CONCLUSION

The results of the study show that there is a great opportunity to utilize virtual laboratories in teaching biology in high school. Virtual laboratories can be used as a solution to the lack of laboratory facilities in schools and are following elements of science learning and can help improve students' critical thinking skills because with virtual laboratories students can build their knowledge through a series of practicum activities. This is certainly supported by the habits of students who use technology such as smartphones to help them learn.

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