ABDIMAS
Jurnal Pengabdian kepada Masyarakat
https://journal.unnes.ac.id/journals/abdimas/

Virtual Biology Laboratory Training for High School Biology Teachers and Laboratory Technicians in Yogyakarta

Oktira Roka Aji*, Ambar Pratiwi, Nurul Suwartiningsih, Sutan Nur Chamida Tri Astuti, Nursyiva Irsalinda

Universitas Ahmad Dahlan, Indonesia
*Corresponding author: oktira.aji@bio.uad.ac.id

Abstract
As the COVID-19 pandemic comes to an end, education has returned to normal with in-person learning. The good practices in online learning conducted during the pandemic can be maintained to support practical activities, for example, using a virtual laboratory. The limitations of laboratory facilities and the skills of educators and laboratory staff in developing practical materials have made Biology practicals minimal and monotonous. Based on discussions with partners, there is a main problem that needs to be addressed through this program, which is the limited laboratory facilities in terms of tools and materials, resulting in minimal implementation of Biology practical activities in schools. The objective of this community service is to enhance the knowledge, skills, and empowerment of Biology teachers at Muhammadiyah high schools in Yogyakarta City in conducting practicals using virtual labs. This community service method is carried out by training on Biology practical learning online using virtual labs. This program is conducted in several sessions, each lasting 200 minutes, from June to October. Each session consists of a pre-test, material delivery, Q&A discussions, and a post-test. It can be concluded that the community service activities ran smoothly and provided benefits in the form of increased knowledge and skills of participants in Biology practical learning using virtual labs.

Keywords: Biology, Practical, Virtual Laboratory

INTRODUCTION

Several common teaching methods often applied in educational institutions include classroom learning or lectures, laboratory activities or practicums, projects or assignments, online learning or e-learning, fieldwork, and distance learning. In the teaching of science and technology, laboratory skills and theory are interconnected, with theory providing a foundation and understanding of key concepts in a field of science, while laboratory skills enable students to apply these concepts in practical situations (Ahdar, 2019). Students with good laboratory skills can understand and apply theoretical concepts more effectively and efficiently in a laboratory setting (Emda, 2017).

Laboratory learning also poses its own challenges, especially for educational institutions that lack adequate laboratory facilities, lack of knowledge and skills among teachers in creating learning media for practical activities, and limited practical skills in the laboratory. The lack of laboratory facilities can hinder the development of students' practical skills in science and technology (Rahmawati et al., 2021). Currently, the availability of equipment and materials in laboratories is very limited. Limited funds to acquire practical equipment and materials result in minimal and low-quality laboratory tools, which are insufficient to support practical activities.

Teachers who are too focused on theoretical aspects also cause students to be less trained in the practical application of the theoretical concepts they learn. Laboratory experience is a crucial factor in achieving biology learning objectives. According to Ratnawati (2020), student-centered learning should be implemented so that learning is not solely focused on theoretical concepts (Ratnawati, 2020). In this regard, educators are required to be creative and innovative to make learning interesting, prevent students from getting bored during practical lessons, and allow students to gain optimal learning experiences through practical activities. Educators must innovate in delivering

lessons by maximizing technology because educators play a significant role in the success of achieving learning objectives (Mirdayanti, 2020; Sabaniah et al., 2021).

With the end of the COVID-19 pandemic, learning has returned to normal and is being conducted face-to-face. The pandemic has brought significant changes in the use of media and technology in education, which should be maintained. One innovation in learning practice is the virtual laboratory, where a virtual lab is a platform that provides online laboratory simulations to offer realistic and interactive practical experiences for students without having to be in a physical laboratory.

Based on the analysis of the situation and conditions mentioned above, the identified problems are: (1) Students' low understanding of biological concepts if learning is only conducted theoretically, (2) The low availability of equipment and materials in school laboratories to support biology practical activities, (3) Teachers' limited skills in developing online practicums using technology, and (4) The minimal and monotonous implementation of practicums due to teachers' limited skills in developing practical activities. Therefore, the main problem that needs to be addressed through this community service program is the limitation of laboratory facilities in terms of equipment and materials, which leads to minimal implementation of Biology practical activities in schools. The participants of this community service program are Biology teachers from Muhammadiyah High Schools in Yogyakarta City, under the coordination of the Muhammadiyah Education Council for Primary and Secondary Education (DIKDASMEN) Muhammadiyah PDM Yogyakarta City. The problem-solving solution offered by the community service team is training and assisting in the creation of online practical learning media. Thus, the community service program aims to enhance the knowledge, skills, and abilities of Muhammadiyah High School Biology teachers in Yogyakarta City in developing Biology practicums.

METHODS

This community service activity is carried out through training on creating online Biology practical learning media. The training is planned to be conducted both offline (face-to-face) by applying health protocols at one of the Muhammadiyah High Schools in Yogyakarta City. This training is a solution to the minimal implementation of Biology practicums and the limited laboratory facilities. Web-based learning allows for its integration into online practical work (Estriegana et al., 2019). The implementation of practicums using a virtual lab is presented to the training participants with the hope of encouraging them to find appropriate and effective learning media. The details of these activities are shown in Figure 1.

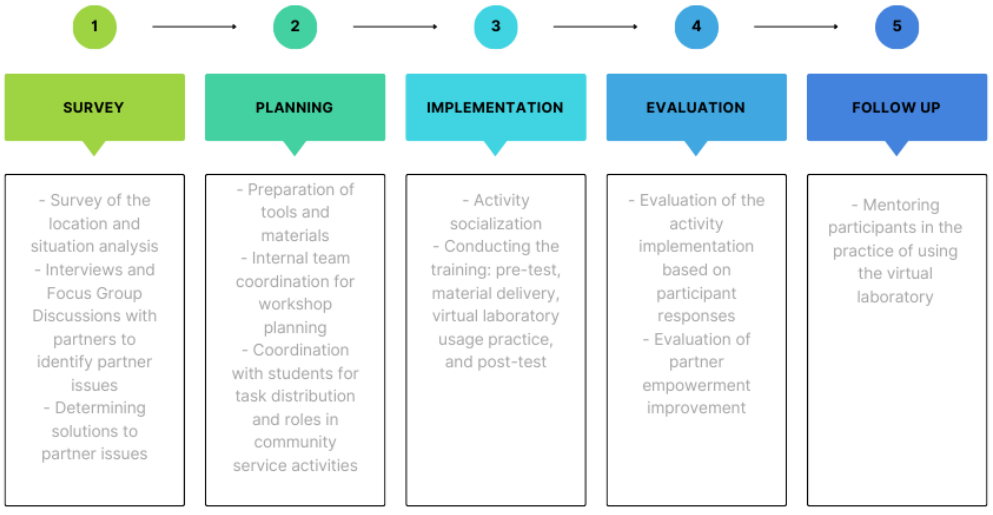

Figure 1. Stages of Community Service Implementation

The implementation of this community service program is divided into several sessions, each lasting 200 minutes, from June to October. Each session of the program consists of a pre-test stage, material presentation, Q&A discussion, and post-test. The proposing team consists of 3 lecturers and 2 students from the Biology Study Program, Faculty of Applied Science and Technology. The partner in this community service program is the Muhammadiyah Education Council for Primary and

Secondary Education (DIKDASMEN) Muhammadiyah PDM Yogyakarta City. The partner's participation in the program implementation includes coordinating training participants (Biology teachers and laboratory technicians of Muhammadiyah High Schools in Yogyakarta City) and facilitating follow-up training activities. The community service program aims to improve the partner's knowledge and skills in delivering online learning and practical material. The program evaluation is conducted through pre-tests and post-tests to measure the increase in participants' knowledge and skills after the training. After the PkM (Community Service Program) activities, this program will continue by providing assistance to the participants.

RESULTS AND DISCUSSION

This community service activity was attended by 20 Biology teachers and laboratory technicians from high schools in Yogyakarta City. The training was divided into several sessions. The first session began with a review of high school Biology practical materials with the participants. In this session, discussions were held on which materials are the most difficult and frequently encounter obstacles during practical implementation. The next session was the introduction and training on the use of virtual labs. This community service activity was in the form of training on creating online Biology practical learning media (Figure 2).

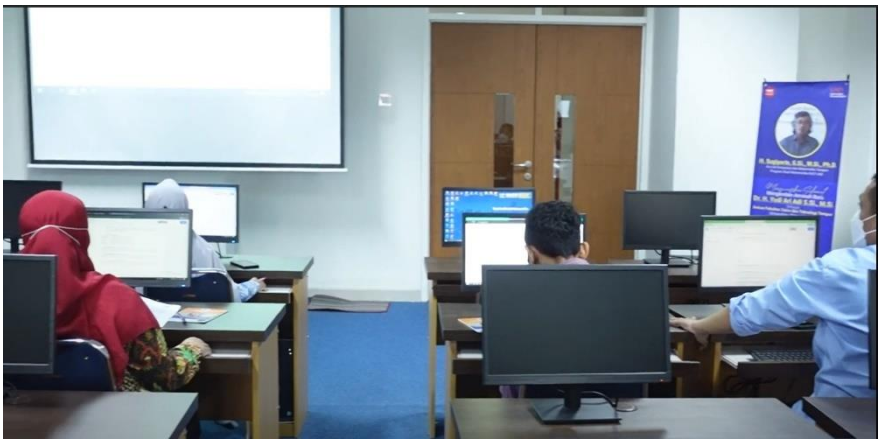

Figure 2. Documentation of Training on Creating Online Biology Practical Learning Media

The training participants were very enthusiastic and actively engaged throughout the event, as evidenced by the numerous questions they asked during the sessions. The positive impact of this training on the partners can be seen from the questionnaire results, which show their satisfaction, as depicted in Figure 3. The data from the questionnaire provides valuable information on how well the training was conducted and to what extent the partners benefited from it. The conclusion drawn from the active participation of the participants and the positive results of the evaluation shows that this training not only met the participants' expectations but also provided tangible benefits to the involved partners.

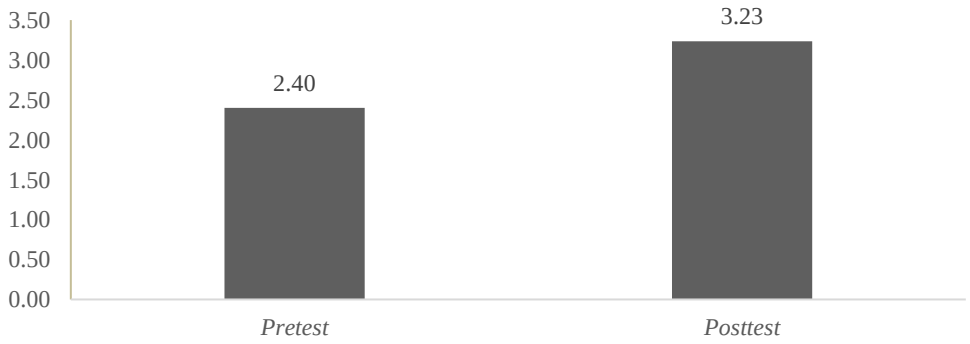

Figure 3. Summary of Participants' Questionnaire Responses in the Training on Creating Online Biology Practical Learning Media

Based on the questionnaire results, it is evident that the participants' understanding and skills improved after attending the training. To evaluate whether this difference is significant, statistical analysis was conducted using normality and Mann-Whitney tests. The normality test results showed that the data were not normally distributed ($p<0.05$), so the non-parametric Mann-Whitney test was used. The Mann-Whitney test results indicated a significant difference between the pre-test and post-test results ($p<0.05$). Thus, it can be concluded that the training significantly improved the participants' understanding and skills. This evaluation confirms that the training had a real positive impact on enhancing the participants' knowledge and skills.

Laboratory practice provides valuable experience for students, allowing them to complete practical tasks quickly and produce accurate data. This data can be used to test hypotheses and answer research questions. Students with poor laboratory skills may struggle to apply theoretical concepts in practice, including following instructions, taking measurements, and managing data. These deficiencies can result in a poor understanding of theoretical concepts, negatively impacting their academic and professional performance (Sari et al., 2020). Therefore, learning through laboratory practicums is a crucial aspect of education.

Implementing practicums in schools often faces various obstacles, and an effective solution to overcome them is by utilizing virtual labs. Common challenges in conducting practicums in schools include limited resources, such as practical equipment and materials, as well as time and space constraints in the laboratory. The use of virtual labs can be a solution because they provide access to experiments and simulations digitally, eliminating reliance on physical supplies and overcoming logistical barriers. Additionally, virtual labs allow students to conduct experiments independently and understand concepts more deeply without being constrained by time and facility limitations. Therefore, using virtual labs not only addresses the challenges of practicums in schools but also opens opportunities for increased accessibility and effectiveness of practical learning in the context of biology education.

Virtual labs enable students to conduct experiments, observe equipment, and see results in real-time through a digital platform. Moreover, students can apply various biological concepts and theories in this virtual laboratory environment. The main goal of using virtual labs is not only for students to understand biological concepts theoretically but also to have practical skills to apply scientific methods to prove these concepts according to the theories studied. According to Arifin et al. (2020), virtual laboratories have the potential to assist students in conducting investigations and experiments without being limited by time, equipment limitations, and the availability of materials, which are often constraints in conventional practical activities. Therefore, the use of virtual laboratories not only complements the theoretical aspects of biology learning but also opens opportunities for the development of students' practical skills. As Hidayat (2018) mentioned, practical activities can develop various student skills, including observation abilities, hypothesis formulation, accuracy, experiment planning, reporting results, and stimulating critical thinking skills.

Some advantages of virtual labs in biology practicums include: (1) Reducing safety risks, as biology practicums often involve materials and equipment that can pose safety hazards, allowing students to learn without worrying about safety risks, (2) Saving costs: virtual labs do not require special equipment or expensive materials, thereby saving costs for schools, (3) Increasing accessibility: virtual labs can be accessed from anywhere and anytime, as long as there is an internet connection, enabling students in remote areas or with physical limitations to access and learn biology practicums, (4) Increasing flexibility: virtual labs allow students to conduct experiments repeatedly to improve results, perform experiments that are not feasible in real situations, and access various types of biology experiments that may not be available in physical laboratories, (5) Enhancing student engagement: virtual labs enable students to learn biology concepts and practicums in a more interactive way, including better visualization, simulations, and engaging animations, thereby increasing student engagement in learning and strengthening their understanding of difficult biology concepts. With these advantages, virtual laboratories can be a good alternative in biology practical learning in schools. However, it should be noted that virtual labs cannot fully replace the direct and practical experience in physical laboratories.

ACKNOWLEGMENT

We would like to extend our gratitude to the Institute for Research and Community Service (LPPM) Universitas Ahmad Dahlan for providing the opportunity to carry out this community service through funding. Our thanks also go to our partners, especially the Muhammadiyah Education Council

for Primary and Secondary Education (DIKDASMEN) Muhammadiyah PDM Yogyakarta City.

CONCLUSION

The training on creating practical learning media conducted as part of this community service program has successfully enhanced the participants' knowledge and skills significantly. The follow-up recommendation for the program includes testing and evaluating the use of virtual labs in technology-based learning.

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