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Articles Review

Utilizing Virtual Laboratories (V-Labs) to Facilitate Learning in Vocational High Schools: A Systematic Literature Review

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Abstract

The digital learning resources are diverse and have the potential to be optimally utilized by educators. However, only a few are aware of the opportunities for utilization. Therefore, the purpose of this research is to describe the implementation of virtual laboratories (v-labs) as one of the learning resources in various educational levels. This research is conducted using the Literature Review method, with data sources consisting of 13 selected articles based on keyword analysis and publication year from scientific articles, as well as other publications sourced from databases such as Google Scholar and Scopus.com. The data analysis technique used in this research is descriptive analysis technique, so that the findings of the articles can be analyzed descriptively in terms of the implementation of virtual laboratory technology in learning activities. The review of several literatures shows that virtual laboratories can be applied and integrated into the learning process, becoming one of the learning resource options for practical learning. It is known that through the implementation of virtual laboratories, interactive elements are included, allowing students to actively participate and access learning resources without time constraints. Through this research, it is hoped that virtual laboratories can be adopted by teachers in vocational education considering the great opportunities and potential they have to facilitate learning.

Keywords: *Virtual Laboratory, Vocational High School, Interactive, V-Lab*

INTRODUCTION

The current technological advancements have brought about highly positive impacts on the field of education. Numerous aspects can be explored, created, and developed through the utilization of technology (Wang & Yin, 2021). The utilization of technology in the current learning process has brought about positive impacts as educators are able to utilize technology to create various creative and engaging educational media for students (Yildirim & Sensoy, 2018). Considering the current progress of education at various levels in Indonesia, numerous educators have introduced the utilization of technology in teaching and learning activities (Ningsih et al., 2022). However, many educators in certain regions still utilize textbooks as the primary resource in teaching and learning activities. This allows for a lecture-style approach, where the teacher provides explanations and the students listen. Such learning activities are considered monotonous and uninteresting, as the learning process appears to be less active and less creative.

Unbeknownst to them, the advancement of technology has had an impact on students compared to the past, where technological progress was not as significant and advanced as it is today (Kiyici, 2018). For instance, in everyday life, individuals tend to engage more with their mobile phones (HP), which are technological products, rather than dedicating time to reading textbooks (Rahman & Aeni, 2021). The rapid advancement of technology in the era of globalization has made it easy for humans to access information from anywhere and at any time (Mulyadi, 2019). However, educators have not yet been able to optimize these opportunities.

From the perspective of the educational level of Vocational High Schools (SMK), schools at this level have a clear focus and objective, which is to prepare students for the workforce. In comparison to training in general high schools (SMU), the approach in vocational schools is more practical and focused on specific skills needed in the industry (Suharno et al., 2020). The primary

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objective of vocational training in schools is to produce graduates who are ready to enter the workforce and equipped with practical skills required in the industrial world (Bunyamin et al., 2022). Therefore, vocational schools tend to prioritize practical training over theoretical training. Vocational school students need to participate in numerous practical activities aimed at enhancing the skills required in specific fields such as manufacturing, repair, and services (Divayana et al., 2021).

Teachers play a vital role in vocational schools by ensuring that students acquire industry-relevant skills through hands-on learning. They are not just providers of learning materials, but also valuable learning companions. To successfully teach skills, teachers must be able to provide effective learning resources. One suitable solution is to incorporate information and communication technology (ICT)-based learning resources (Aidarbekova et al., 2021). This approach is in line with the progress of time and the increasing demand for skills in the industry. By utilizing ICT, teachers can provide students with opportunities to learn practical skills interactively and comprehensively (Prestridge, 2012). Learning resources based on ICT can come in the form of engaging learning applications, video tutorials, virtual practice simulations, and other online sources that students can access flexibly (Martines, 2021).

One form of ICT-based learning resources is virtual laboratories, which are highly suitable for facilitating practical skills for vocational high school students (Nirmala & Darmawati, 2021). V-Lab, also known as Virtual Laboratory, is a computer simulation that replicates real-world laboratory experiments (Mulders et al., 2020). V-Lab enables students to conduct safe and efficient scientific and engineering experiments without the need for physical equipment and materials (Siregar et al., 2022). V-Lab possesses several inherent characteristics, namely Interactivity, Flexibility, Affordability, and a high level of security (Estriegana et al., 2019). Despite this, the utilization of V-Lab will also have the capability to enhance access and equality, boost motivation and engagement, improve conceptual understanding, as well as develop 21st-century skills (Lestari et al., 2021). It cannot be denied that the presence of Virtual Laboratories for vocational high school students will provide benefits in enhancing their understanding of science and technology subjects, preparing students for employment in the industry, and improving the skills of graduates. The use of v-labs is one alternative that teachers can utilize during the learning process in the classroom, as several studies have proven and shown that virtual laboratories can facilitate vocational high school students in learning practical subjects (Yanto et al., 2022), Enhancing students' expertise (Muslim et al., 2022), improving students' abilities and achievements, and elevating the skills required for the 21st century.

The use of V-Lab in education has been found to have several benefits. Many research also shows that using V-Lab can improve student participation, critical thinking, learning outcomes, motivation, analytical thinking, and reduce the time spent on practical activities. This article aims to describe and explore the role of V-Lab in education through a literature review of its implementation and impact on learning activities.

RESEARCH METHOD

This research is a type of literature review study (Snyder, 2019), The utilization of this particular type of research aims to provide information that is focused on a specific topic. The technique of detecting or solving a particular problem, or conducting a literature review, can be considered as a scientific process that yields results in the form of a report, which aims to conduct scientific research or focus the research (Kurniawan et al., 2019).

The research data for this study was collected from various academic journals in the form of materials or documents related to the topic being discussed (Cooper, 1998). The reference data sources used in this research include academic journals and electronic books. The data collection

method involved document review through library searches in various academic article databases such as Google Scholar and Scopus, with a search range from 2018 to 2022 (Cherni et al., 2020). The data analysis method used in this study is descriptive analysis method (Silalahi, 2015). By systematically grouping the data obtained according to the criteria and variables relevant to the research topic, namely "V-Lab, Virtual Laboratory; Vocational High School; 21st Century Skills", the definition and explanation will be described descriptively to facilitate readers in understanding the research findings.

FINDINGS AND DISCUSSION

The following presents the findings of various articles from the referenced database sources, which were searched based on predetermined keywords or variables in the research methodology. The findings of a number of selected articles serve as the data source and are presented in Table 1.

Table 1. Findings and results of the research conducted

No.	Author	Results
1.	Bogusevschi et al., (2020)	This paper presents an analysis of the user experience and usability results of the developed application, showing a high user experience score. The experimental group students also found the application enjoyable and they would like to take part in such novel-approach lessons more often.
2.	El Kharki et al., (2021)	Virtual labs have become crucial in science education because of advancements in information and communication technologies. These online labs provide a valuable substitute for traditional hands-on labs. Moreover, virtual labs can help sustain higher education.
3.	Zulkifli et al., (2022)	The use of PhET Virtual Laboratory and Real Laboratory has a significant effect on students' cognitive physics learning outcomes. PhET Virtual Laboratory and Real Laboratory are effective for teaching Elasticity and Hooke's Law as an alternative to physics experimental activities.
4.	Hamid et al., (2021)	During the COVID-19 pandemic, we conducted performance efficiency testing on the Unity 3D and Blender-based virtual laboratory media at the Electrical Engineering Vocational Laboratory.
5.	Sasongko and Widiastuti, (2019)	The virtual lab can be applied to practical learning in vocational education, for example in the field of mechanical engineering it can be applied in learning to maintain fuel systems on the engine, with characteristics in the form of procedural steps.
6.	Maulana et al., (2021)	After using the Virtual Reality application learning media, the assessment of students obtained an average value of 3.77 compared to conventional assessments with an interval of 2.71. The use of Virtual Reality technology has proven that it can help and facilitate student learning.
7.	Zhao (2019)	The discussion focused on the importance of experiment teaching and scientific research to enhance the construction and management of virtual simulation laboratories.
8.	Siregar et al., (2022)	This research and development found virtual laboratory for practical learning in vocational education using the nine events of instruction approach which in this approach in learning is a systematic process that has a behavioral approach with a focus on outcomes or behavior during the learning process.
9.	Wahyuman et al., (2021)	This study indicates that the effect of the webqual 4.0 method in the Virtual Reality Laboratory on Student Cognitive Engagement is 57.2%. The direction of the influence of the X and Y variables is positive.

10.	Kurniati et al., (2023)	The findings indicated that system quality exerted a favorable impact on system use, while service quality also had a positive influence on system use.
11.	Yanto et al., (2022)	The results showed that the virtual laboratory was effectively used as a practicum learning media with a large effect category. Thus, it can be concluded that the virtual laboratory can be an effective choice for implementing practical learning in supporting the implementation of remote learning.
12.	Keleş et al., (2022)	The experimental group performed laboratory simulations based on biochemistry and microbiology and then completed a self-report survey to evaluate their satisfaction and beliefs about simulations. In the experimental group, post-test scores of each simulation were significantly elevated compared to pre-test scores.
13.	Gunawan et al., (2019)	The study discovered that the experimental group had better science process skills compared to the control group. The use of guided inquiry models with virtuals laboratories had a notable impact on science process skills, particularly in hypothesizing, practicing, and communicating.

Thirteen relevant articles have been found through analyzing different articles using keywords and research variables. These chosen articles are sourced from various databases like Google Scholar and Scopus. Some of them show that the utilization of virtual laboratories or V-Labs greatly benefits student learning outcomes, including cognitive abilities, attitudes, student skills, and the improvement of 21st-century soft skills (Nirmala & Darmawati, 2021; Siregar et al., 2022). This is definitely worth considering as one of the learning resources that can be applied by teachers, especially for vocational high school teachers, considering that most of their students do require affordable practical equipment to sharpen their skills.

Teachers can use various factors as a basis for incorporating V-Lab learning resources. The use of V-Lab in vocational schools (SMK) can offer advantages in terms of comprehending scientific and technical subjects, as well as equipping students for future employment in the industry (Yudiono et al., 2022). Furthermore, the overall objectives of utilizing V-Lab can be understood as an effort to provide practical materials that are accessible to students with various characteristics, without concern for the amount of time they require to practice their skills (Yanto et al., 2022).

Several studies have indicated that the majority of V-Lab implementations aim to facilitate practical and scientific learning (Zhao, 2019; Gunawan et al., 2019), This certainly has great potential to be implemented sustainably in vocational education. The presence of V-Lab will enable the learning process to provide students with the necessary practical knowledge to excel in tackling challenges in the industrial world (Skobelev & Borovik, 2017). According to several studies, the utilization of V-Lab has been found to have a positive impact on scientific process skills, indicating that it is not only a lack of skills that hinders entry into the industrial world (Gunawan et al., 2019), student learning intereset (Maulana et al., 2021), and learning outcomes (Zulkifli et al., 2022).

The implementation of V-Lab in school learning brings various benefits. It makes learning more engaging, interactive, and flexible. It also reduces teaching time and improves the quality of student practical work. With V-Lab, teaching and learning activities can take place anytime and anywhere. Teachers can facilitate practical learning in vocational high schools effectively. However, to ensure optimal learning outcomes, factors like learner characteristics should be considered when using V-Lab. Overall, using V-Lab will provide stable and optimal results.

CONCLUSIONS

Based on the analysis and discussion of the conducted research, it can be concluded that V-Lab can serve as an initial solution when students require more time to engage in practical activities. It has been proven that the utilization of V-Lab, based on several research reviews, is capable of enhancing students' skills and motivation in practical learning. Furthermore, this literature review suggests that teachers should implement and utilize virtual laboratories in vocational high school education, enabling students to develop their skills in accordance with the learning outcomes and achievements in their school.

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