The Future of Archives Learning with Technology: Exploring the Potential of Virtual Labs

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A R T I C L E   I N F O

A B S T R A K

Penerapan media interaktif di SMK sangat mendesak untuk meningkatkan efektivitas pembelajaran. Dalam era digital, media interaktif dapat memotivasi siswa, meningkatkan pemahaman, dan mempersiapkan mereka dengan keterampilan berbasis teknologi yang relevan untuk masa depan. Oleh sebab itu, penelitian ini bertujuan untuk menganalisis potensi dan peluang pengembangan sebuah multimedia interaktif berbasis Lab – Virtual (V-Lab) untuk pembelajaran kearsipan di SMK. Penelitian ini termasuk ke dalam pendekatan mixed method. Subjek penelitian terdiri atas 2 guru, dan sejumlah 103 siswa. Sementara data yang dikumpulan berupa data kualitatif dan kuantitatif. Data kualitatif dikumpulkan dengan Teknik pengamatan, dan wawancara yang instrumennya yaitu lembar pengamatan dan pedoman wawancara. Data kuantitatif dikumpulkan dengan Teknik non tes yatiu Angket dan diikuti kuisioner sebagai instrumennya. Data hasil penelitian akan dianalisis dengan secara deskriptif dengan analisis interaktif melalui pengumpulan data, reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa selama pelaksanaan pembelajaran, guru pada dasarnya sudah menggunakan media berbasis TIK yang terbatas pada jenis slide presentasi, youtube dan internet, respon siswa menyatakan mereka memikirkan kehadiran sebuah inovasi media yang interaktif dan bisa dioperasikan di smartphone yang mereka miliki khususnya untuk pembelajaran kearsipan, hampir sebagian besar siswa juga setuju terhadap pengembangan multimedia interaktif berbasis Lab Virtual untuk memudahkan mereka melakukan praktik, hal ini tentu merupakan inisiatif dan keinginan yang harus diwujudkan agar tercipta pelaksanaan pembelajaran yang inovatif dan dinamis. Hasil penelitian ini dapat dijadikan sebagai dasar untuk mengembangkan inovasi pembelajaran dengan format yang interaktif dan memuat unsur digital karena bisa dioperasikan di smartphone, serta dapat menunjang aktivitas pembelajaran di SMK.

A B S T R A C T

The use of interactive media in vocational schools is extremely important for improving learning effectiveness. In today's digital era, interactive media can inspire students, improve understanding, and provide them with technology-driven skills that are relevant for the future. Therefore, the aim of this study is to analyze the potential and opportunities for creating an interactive multimedia platform called Virtual Lab (V-Lab) for archival learning in vocational schools. This research used a mixed method approach, with a sample size of 2 teachers and 103 students. The data collected includes both qualitative and quantitative data. Qualitative data was gathered through observation and interviews, using observation sheets and interview guidelines as tools. Quantitative data was collected through non-test techniques, specifically questionnaires, followed by data analysis using questionnaires as tools. The research data analyzed descriptively through interactive analysis, which involves data collection, data reduction, data presentation, and drawing conclusions. The findings of this research showed that teachers mainly used ICT-based media, such as presentation slides, YouTube, and the internet during the learning process. Additionally, a large majority of students expressed their agreement towards the development of Virtual Lab-based interactive multimedia, as it enhanced their practical learning experiences. This initiative and desire must be realized in order to promote innovative and dynamic learning implementation. The outcomes of this research could serve as a basis for the development of learning innovations, particularly in terms of interactive learning media that incorporate digital elements, which could be accessed through smartphones and support learning activities in vocational schools.

1. INTRODUCTION

The current state of education in Indonesia faces significant challenges in facing the 21st century. Despite education reform efforts, there is still an imbalance in the utilization of information and communication technology (ICT) to support the learning process (Agyei & Agyei, 2021; Siregar & Marpaung, 2020). In the era of globalization and industrial revolution 4.0, the sustainability of education requires increased accessibility, curriculum relevance, and the implementation of interactive media that can prepare students with relevant skills,

such as digital literacy and problem solving, to compete in an increasingly digital and dynamic environment (Dewi & Hilman, 2018; Laar et al., 2020). Meanwhile, the education system has important components that form the main foundation of the learning process. One of the key components is the curriculum, which formulates the material taught and the learning objectives (Ahern et al., 2012; Diana et al., 2019). Teachers, as the main agents in the system, have a crucial role in implementing the curriculum. In addition, infrastructure, including technological facilities and devices, is also an important part of the education system (Haldorai et al., 2021; Hoesni et al., 2020). All these components interact and influence each other in creating an effective and quality learning environment.

In addition, it is recognized that the development of digital culture in the 21st century encourages the use of digital resources and communication tools in school learning activities (Christian Pilarta Oliquino, 2019; Meilani & Aiman, 2020). Learner success in learning related to digital literacy. However, the use of digital technology is not supported by digital literacy skills as basic literacy equivalent to reading, writing and arithmetic skills (Ilomäki et al., 2016; Misir, 2018; Muslimin et al., 2023). Digital literacy is not only about the understanding of operating technology, but also the ability to manage information correctly, critical thinking skills and also appropriate network behavior (Fazilla et al., 2022; Hamutoğlu et al., 2019; Yudiono et al., 2022). In addition to digital literacy, one of the important competencies to be mastered by other students is problem solving (Hendriana et al., 2018; Techanamurthy et al., 2018). Problem solving is a critical skill that students must master. It involves the ability to identify, analyze, and find solutions to complex or unstructured problems. This skill involves several stages, such as understanding the problem, analyzing the causes, identifying solution options, and evaluating the most appropriate solution (Abate et al., 2022; Rahman et al., 2022; Salsabila & Pradipta, 2021; Yuliati et al., 2018).

The importance of this ability is not only limited to the academic context, but also has a significant impact in everyday life and in the world of work. Students who are proficient in problem solving tend to have better critical thinking skills, can tackle challenges with more confidence, and are able to deal with complex situations (Findeisen & Wild, 2022; Wilkin, 2017). This ability also increases students' competitiveness in an increasingly competitive job market, as many jobs today require problem-solving skills. In addition, problem solving also supports the development of creative and innovative thinking skills, as it often involves unconventional ways of thinking (Komaro et al., 2021; Sukmawati, 2021). Thus, this ability helps students to become more independent individuals and able to face future challenges with confidence. Therefore, understanding and mastering problem-solving competencies are very important in modern education.

One sign of progress in the utilization of digital technology can be observed through the increase in internet usage. According to information from Indonesia's Central Bureau of Statistics in 2020, internet usage reached 78.18%. The data shows that cell phone users reached 62.84%, while computer ownership has increased to 18.83%. The APJII survey in 2017 also indicated that internet users in the 15-19 age group reached 91%. The results of the digital literacy assessment of most youth in Indonesia, showed that the majority gave a score of 3 on a scale of 1 (poor) to 5 (excellent) (Brata et al., 2022; Htake & Tin, 2019; Swandi et al., 2020). Thus, the data presented shows that digital literacy in Indonesia has not kept pace with the high internet usage in the country.

Therefore, learning activities certainly need to pay attention to components or aspects that can support or optimize the learning process. As some opinions reveal about other advantages of interactive media that are not only in the form of text but can include animated images video music or sound (Wiyono et al., 2019). Moreover, in practical learning activities, practicum cannot always be carried out due to limited equipment and time. With the advancement of computer technology, one of the things that can be done to overcome this is to simulate some practical activities using multimedia with a virtual laboratory format. Several studies that have been conducted related to interactive multimedia and virtual laboratories or V-Lab, As per the research conducted by previous studies stated that interactive multimedia can improve learning outcomes carried out in vocational schools and can help students' practical activities (Bima et al., 2021; Widodo et al., 2020). Other study, the activity is carried out by the organization have also successfully developed a virtual laboratory capable of improving practical skills for school students, and interactive multimedia that can also be developed for other subjects as well as its impact that contributes positively to improving student academic achievement (Sriadhi et al., 2021). Not only that, but other research conducted show the results showed that the use of virtual laboratories can enhance 21st century skills, such as metacognition and literacy, where V-Lab has a positive impact on the improvement of both 21st-century skills (Nirmala & Darmawati, 2021). Several studies have shown that they have successfully developed a Virtual Lab media for enhancing 21st-century skills such as metacognition, literacy, and problem-solving abilities. It is evident that there is potential for V-Lab to further enhance other 21st-century skills, such as critical thinking, which, according to some studies, has not yet been researched in vocational secondary education.

Implementation of the new national curriculum called independent curricula means that teachers must urgently innovate – innovate in order to harmonize the learning process with the learning supporting equipment and media (Bilousova et al., 2020; Sihombing et al., 2021). The results of the field facts indicate the need for an

integration of ICT into the learning process as one of the forms of learning innovation. Besides, students also need to be equipped with the competences – competences required in the 21st century, one of which is problem-solving or problem solving that is in line with the purposes set forth in the Merdeka curriculum (Septiana, 2023; Widiyono, 2021). Nowadays, preparedness learning is already a lot that applies technology as a tool for learning, both to explain the material and to be used as a support for the work of the Exercises. Nevertheless, no research has been found to utilize ICT into preparedness learning with viral laboratory formats to enhance skill problem solving of vocational students (Hoesni et al., 2020; Som, 2021). As one of the topics considered sufficiently demanding skills to solve contextual problems, the combination of archival material and ICT is expected to provide students with the option to practice and learn interactively (Salma Aprianka, 2020; V. S. Sari et al., 2021). It also gives students greater hope of acquiring skills – skills that are needed in the 21st century (Habibi & Suparman, 2020; Yulianisa et al., 2018).

Based on various descriptions derived from research findings, it is widely acknowledged that the integration of ICT into the learning process, in line with the national curriculum, is of utmost importance. The implementation and development of a virtual laboratory in archival learning holds significant potential, as it is believed that relevant research synthesis can have a positive impact on students' competency achievement. Furthermore, previous studies have extensively focused on the development and validation of virtual laboratories for vocational schools and high schools, albeit with limited research on holistic planning for creating virtual laboratories. It is undeniable that the integration of virtual labs in education is imperative to enrich the teaching and learning process and enhance students' competencies. Recognizing this gap, a needs analysis is necessary to explore the development opportunities of a virtual laboratory for archival learning in vocational schools. This endeavor can be considered a novelty, as limited research has been conducted on this topic. It is crucial to implement this initiative to ensure the creation of a v-lab product that aligns with students' characteristics and addresses the skill requirements that need to be enhanced. Hence, the primary objective of this research is to ascertain the prospects and possibilities associated with the integration of a virtual laboratory that aligns with the attributes of the students, curriculum content, and fulfills the requirements of the school.

2. METHOD

In the implementation of this research, a mixed approach or mixed method was used to collect data. This approach involves collecting data in both qualitative and quantitative forms (Creswell et al., 2003; McKim, 2017). To obtain quantitative data, this study will involve 103 students in Vocational High Schools as research subjects. Quantitative data will be obtained through the use of a needs analysis questionnaire that has been adapted from previous research and adjusted to the objectives of this study (Ormancı & Çepni, 2020; Susantini et al., 2021).

Table 1. Quantitative Data Instrument Lattice

Aspect	Indicator
Learning	The attractiveness of the learning process
	Subject preferences
	Difficulty understanding the material
Instructional Media	Use of ICT-based media
	A view of the virtual laboratory
	Adaptation from research (Ormancı & Çepni, 2020; Susantini et al., 2021)

Meanwhile, to collect qualitative data, a series of studies were conducted in April 2023 with research subjects consisting of 2 Archival Subject Teachers. The research subject selection technique used purposive sampling technique with the aim that the data obtained was in accordance with the research needs and was able to answer the research questions posed (Sugiyono, 2018). For this qualitative data collection, interview and observation methods were used with data collection tools in the form of interview guidelines and observation sheets. Before being used, these instruments have been validated and consulted with a Supervisor who has a Doctoral Education background, as an instrument validation step through expert judgment (Nurtanto et al., 2020; Syauqi et al., 2020). The following is a lattice of instruments for qualitative data.

Table 2. Qualitative Data Instrument Grid

Data Collection Technique	Aspect	Indicator
Observation	Opening Phase	Providing motivation
		Delivery of learning objectives

Data Collection Technique	Aspect	Indicator
Interview	Delivery of Material Content	Learning Management
		Use of Methods
		Use of Media
		Assignment
	Clsoing Phase	Conclusion
		Providing feedback
	Learning	Material difficulty level
		Student participation and activeness
		Assessment results
	The Use of Learning Media	Use of different types of learning media
		Mastery of ICT tools
		Views on media innovation with ICT format

Adaptation from research (Dewantara et al., 2020; Widya et al., 2021)

The results of the data obtained will be analyzed, for research with quantitative data format has been analyzed by descriptive percentage, while the qualitative data format was analyzed using the Bogdan and Biklen model, and this explanation will be presented in the form of a narrative description that illustrates the strong relationship between themes and subthemes (Fathoni et al., 2021; Roemintoyo & Budiarto, 2021). So that in accordance with the research objectives, the data will be analyzed thoroughly and mutually reinforcing between themes and subthemes.

3. RESULT AND DISCUSSION

Result

This planning activity is basically a series of needs analysis which is then followed up in the initial design process related to virtual laboratory products that will be developed with the support of the Android operating system, in order to improve students' problem-solving skills. Some of the data collection techniques used at this stage consist of observations of the learning process, interviews with teachers who teach archiving subjects at Vocational High School (SMK), and questionnaires analyzing the needs of interactive multimedia development in virtual laboratory format to students.

Results of Interview with Archives Subject Teacher

At this stage of needs analysis, one of the methods employed for data collection is the interview method. The interviews were conducted verbally with subject teachers in SMK. The data obtained from these interviews will serve as a reference point for determining the needs of both students and teachers in terms of interactive multimedia innovations in the virtual laboratory format. The following is a summary of the outcomes derived from the interviews with the teachers. Multiple teachers were interviewed, and overall, they evaluated that in recent years, students have displayed a tendency to be more passive during the learning process. However, the teachers also noted that the low level of student engagement can be addressed by incorporating quizzes or apperception questions at the beginning of learning activities. During the learning activities, it was observed that teachers have been accustomed to utilizing a teacher-centered and one-way learning model, primarily through lectures and assigning tasks. According to the teachers, lessons should always be supplemented with assignments in the form of solving cases or problems. Thus far, it can be concluded that the cognitive performance of students in answering questions and solving case-based assignments falls within the satisfactory range. This is because there are some students who are able to answer assignments effectively, while others struggle to provide comprehensive descriptions when answering questions or completing assignments.

Based on the interviews conducted, it was found that the majority of teachers utilized various learning media such as textbooks, PowerPoint presentation slides, and online resources like YouTube and websites. Furthermore, during additional questioning, the teachers unanimously acknowledged the significance of problem-solving ability as a crucial skill for students. They also agreed that traditional lecture-based learning methods and assignments alone are insufficient for enhancing problem-solving skills. They emphasized the need for tools and resources that can deliver subject matter effectively and capture students' attention and engagement.

In this study, the subject teachers who participated as informants expressed their consensus on the innovation of interactive multimedia with a virtual laboratory format. They believed that this approach would facilitate student practice activities and provide an optimal learning experience. The teachers hoped that the implementation of this media would stimulate students effectively and ultimately enhance their problem-solving skills. Additionally, the teachers displayed a positive attitude towards an instructional product development plan. Specifically, they supported the idea of interactive multimedia with a virtual laboratory format that can be

accessed through students' smartphones. They viewed this as a valuable initiative to archive learning materials and contribute to the improvement of students' problem-solving abilities.

Results of the Virtual Laboratory Development Needs Analysis Questionnaire

This section presents the findings of a study that aimed to identify the needs of students in relation to the creation of interactive multimedia teaching materials in the form of V-Lab format, which supports archival learning in Vocational High Schools (SMK). The survey was administered to a group of classes, with a total of 103 students participating as respondents. The survey consisted of various questions designed to gather information on students' needs, including six optional questions and one open-ended question soliciting their opinions or comments. The distribution of this questionnaire holds great significance, as it plays a crucial role in the development of interactive multimedia learning products in the virtual laboratory format. It is essential to consider the cognitive and affective development of students, as well as address the challenges they face in acquiring specific competencies. By taking into account the characteristics and needs of students in real-world settings, it is anticipated that this development will enhance the provision of learning stimuli and foster the growth of students' critical thinking skills. The outcomes of the questionnaire administered to the students is show in Table 3.

Table 3. Need Analysis Questionnaire Results

No	Question	Response (%)	
		Yes	No
1.	So far, has the archival learning process that you have participated in been fun and not boring?	43%	57%
2.	Is this one of your favorite subjects?	26%	74%
3.	In your opinion, are the materials in this course difficult to understand?	77%	23%
4.	Have you been using ICT-based learning media?	38%	62%
5.	Related to the previous question, do you need learning media in the form of interactive multimedia?	84%	16%
6.	Do you agree with the development and implementation of an interactive multimedia innovation with a virtual laboratory (V-Lab) format?	89%	11%

Discussion

According to the findings derived from multiple meetings and interviews with mathematics teachers, it can be concluded that the teacher's role remains highly influential in the learning process. Teachers tend to rely on the traditional method of one-way lecturing, although there are slight variations in the types of assignments given during these meetings. The results of the interviews with teachers further support this conclusion, and observations in various classrooms also indicate that the learning process incorporates positive elements. In terms of motivation, teachers actively encourage students to maintain their enthusiasm for learning at the beginning of each session. However, the observations also reveal that teachers have not fully utilized ICT-based learning resources, such as digital teaching materials and digital learning media. Instead, they primarily rely on printed teaching materials, such as textbooks, without incorporating additional materials based on digital technology. One technology that is widely used in various aspects of human life, including education, is the smartphone. Based on the data presented in the results section, there are opportunities to utilize smartphones in the learning process, particularly for vocational subjects in schools. The emergence of smartphones in the digital era offers the potential for their use as technological devices in the learning process, commonly referred to as mobile learning (Estriegana et al., 2019; Kumar & Chand, 2019; Suryanda et al., 2019).

In the present day, students have become accustomed to the ubiquity of technology. A survey conducted among students revealed their desire for an innovative and interactive learning medium that can be accessed through their smartphones. This inclination is evident from the majority of students who expressed their preference for such a medium. The utilization of Android-based interactive multimedia in education can undoubtedly yield positive outcomes in the learning process. It can facilitate easier comprehension of subjects, enhance students' motivation to learn, and improve their overall academic performance and skills (Greene et al., 2021; A. I. Sari et al., 2019). In addition, smartphone-based learning can also help students master the skills needed in today's digital era, such as critical thinking skills, innovation, communication skills, problem solving and digital ethics (Kim & Park, 2019; Melumad & Pham, 2021).

It is crucial to prioritize follow-up actions aimed at enhancing the utilization of ICT and incorporating it effectively into the learning process, as indicated by the findings of the needs analysis. Numerous research studies validate that innovative learning is a method that highlights the exchange of information in a bidirectional manner, along with the utilization of learning materials that are pertinent to the subject matter and requirements. Consequently, this comprehensive approach enables the attainment of learning objectives

encompassing cognitive, affective, and psychomotor aspects (Hakim, 2021; Ishaq et al., 2020; Prajana & Astuti, 2020; Rahmawati & Ramadan, 2021). It is customary for a developing nation to prioritize the adoption of digital tools before achieving the utmost level of digital-driven economic optimization. A crucial initial measure involves concentrating on the utilization of digital tools and enhancing their usage within the education sector. Presently, the incorporation of ICT-based digital tools in the learning process within the education sector remains significantly restricted (Lim et al., 2020; Roemintoyo et al., 2022).

If educators harness the potential of smartphones in the learning process, they can leverage the opportunities that arise to create more inventive and imaginative learning materials. Numerous studies have demonstrated that the implementation of V-Lab learning media has effectively enhanced student comprehension and motivation, thereby encouraging active engagement in educational endeavors (Sriadhi et al., 2021; Yulando et al., 2019; Amelia & Harahap, 2021). Hence, the integration of advanced and inventive instructional materials can serve as a viable choice among the array of learning resources available to enhance the student learning journey (Har et al., 2019; Munje & Jita, 2020), the integration of ICT into the learning aspect has demonstrated its ability to positively contribute to the development and quality of education (Hoerunnisa et al., 2019; Siregar & Marpaung, 2020). The results of this study indicate that the opportunity for v-lab-based interactive multimedia to be used in the learning process is very large, through the utilization of mobile learning-based technology and the support of educational institutions (schools), it is hoped that a dynamic, fun, and active learning environment can be created in line with some research that has successfully obtained a positive impact from the application of the application (Cukurbasi & Kiyici, 2021; Komalasari & Rahmat, 2019; Wiyono et al., 2019).

Overall, it looks good from the results of the research which shows that so far android-based interactive media has never been developed and used by teachers to support learning activities, especially in archiving subjects. The primary significance of this study lies in its ability to identify the potential and opportunities associated with the utilization of v-lab in vocational high schools for the purpose of enhancing students' problem-solving thinking abilities. This, in turn, offers valuable insights into the strategies and approaches involved in the development of ICT-based learning tools, such as virtual laboratories. The findings of this research can significantly contribute to the advancement of virtual laboratories in the context of archival learning, thereby creating learning materials that are specifically tailored to meet the needs of students. However, it is important to acknowledge that this study has a key limitation in terms of its generalizability, as it primarily focuses on a single vocational school. Consequently, the applicability of these findings to other educational institutions may be limited, emphasizing the importance of considering the unique characteristics of students when developing learning products.

4. CONCLUSION

Through a series of investigations conducted in this study, it has been demonstrated that the learning process implemented thus far has not been optimal in attaining the desired learning outcomes. The teacher's instructional approach has been limited to utilizing ICT-based learning materials in the form of presentation slides. This identified gap necessitates attention, particularly considering the wide array of ICT-based learning resources available in today's digital age. Furthermore, the synthesis of various research findings indicates that interactive multimedia learning materials in the form of virtual labs have a positive impact on enhancing students' academic performance. Consequently, it is hoped that the outcomes of this study can serve as a foundation for future researchers to further develop interactive multimedia products with a virtual laboratory format in vocational high schools. Additionally, the findings of this research also serve as a motivation for teachers to enhance their skills and competencies in creating multimedia or interactive materials, recognizing that students nowadays are highly familiar with ICT-based devices.

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