

Effectiveness of Virtual Laboratories to facilitate Basic Electronics Engineering Practices during the COVID-19 Pandemic

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Abstract

The virtual laboratory was developed to facilitate Electronic Engineering students in supporting the learning of Basic Electronic Engineering practices during the COVID-19 pandemic. Virtual laboratories provide experiences for students from the real world to cyberspace and facilitate the implementation of practices in the laboratory during the pandemic. This research aims to develop a virtual laboratory that can encourage students to implement Basic Electronic Engineering practices during the pandemic. The method used in this research is Research and Development with a quantitative approach to design a Virtual Laboratory. Based on an Electronic Engineering student survey on virtual laboratory media, the study showed a positive response. However, some students did not subscribe to the internet at home. Data shows that 90% of students responded strongly in agreement and agreement. Therefore, Android-based virtual laboratories in Basic Electronic Engineering are Effective in practical learning. The implication is that virtual laboratories make it easier for students to practice during the COVID-19 pandemic. Virtual laboratories can improve students' skills in basic electronic engineering. Developed media can help self-learning because it can be used anytime and anywhere. The novelty of this research is a virtual laboratory project in Basic Electronics Engineering.

Keywords: Effectiveness Digital Media, Virtual Laboratory, Electronic Engineering

Introduction

At the end of 2019, the world was hit by the COVID-19 pandemic caused by the coronavirus originating from Wuhan, China [1], [2]. The impact caused by the virus is so extraordinary that it paralyzes the world economy. The world of education is also affected by the COVID-19 pandemic, so the face-to-face learning process is temporarily closed. Before the COVID-19 pandemic, learning activities could be carried out in the school environment face-to-face in the classroom. But currently, the learning process is carried out online through internet

media. This is done so that the learning process continues to run and succeed as expected. Online learning has many complaints from educators, lecturers, and students. There is no exception for students of the electronic engineering study program of The State University of Jakarta (UNJ). Lecturers are required to continue to carry out lectures even though they are online. Because there is no preparation for online learning, lecturers must have strategies and designs so that learning activities remain exciting and not monotonous for their students. The learning process is

designed in such a way as to create effective and efficient learning.

The learning process in practical courses is also carried out from their respective homes. To still be able to practice independently, media is needed to facilitate the practice learning process. Considering gender differences and differences in education levels from elementary school to college and students' readiness to follow the online learning process during the pandemic, the willingness of technology used as self-efficacy in online learning also determines student learning outcomes. during the pandemic[3]. During the COVID-19 pandemic, a digital support strategy was needed to meet all student needs. This support can involve a significant linkage between students and student teachers[4]. Online learning is the best solution and solution for the world of education in learning activities as a fulfilment of students to get learning. The survey of 672 institutions with 897 U.S. faculty showed that almost all institutions are turning to emergency instructional approaches with an average of no online learning experience. By changing the form of assignments and exams during online learning, digital material support is very helpful for students in completing tasks and exams from home[5]–[8].

In the Electronic Engineering Education Program, Faculty of Engineering, State University of Jakarta, there is a Basic Electronic Engineering course, one of the expertise courses that electronic engineering students must take. In this course, students must master the theory and have practical skills. The Electronic Engineering Education Study Program prepares its graduates to become teachers in Vocational High Schools (SMK) and work in the industrial world. Electronic engineering education graduates are ready to enter the workforce with these

demands. An educational process is needed that can equip students with theory and practice. In the electronics study program, some courses contain theory and practice. One of the courses having theory and practice is the Basic Electronic Engineering course, commonly abbreviated as ELDAS. Students who take ELDAS courses are accustomed to the views of Resistors, Condensators, Transistors, and others. In addition to these theories to provide mastery of skills, students are taught about practicum. In practice, students are given to measure components, assemble circuits as controls and perform projects. Of course, adequate materials, measuring instruments, and practical equipment are needed with knowledge. Ideally, each student can practice individually with the necessary equipment and components.

Electronic Engineering students must have the skills to use measuring instruments to measure every electronic component worth using. If students are not trained in measuring instruments, there is an error in using measuring instruments in practice. The error can be caused due to the use of AVO meters in measuring current, voltage, and resistance that are not mastered. One solution to minimize the mistakes in component measurement in basic electronic engineering practicums can be overcome with learning media designed explicitly for Basic Electronics practicum courses. The media in question is a virtual laboratory. According to Seerat[9], the media can change an individual's perception by showing a change in viewpoint that might fundamentally challenge the viewer's initial reaction to a character, group, or situation. Based on Seerat[9] statement that media has the effect of changing individual perceptions from different points of view, it is necessary to use media, especially in practical learning.

Previous research has been conducted on virtual laboratory media in the learning process to improve student learning outcomes. Research conducted by Nassef et al.[10] shows that virtual laboratories can introduce education and training skills in learning activities. So that it can accurately measure electrical signals and manipulate synchronized data efficiently[11]. Further research was conducted with experiments by Samosa[12] experimental data showed that student results were greatly helped using virtual laboratories in the conceptual understanding of electronic circuits. DoCircuits on circuit design and engineering analysis skills for second-year students of the Electronics program. Telecommunications improve circuit design and analysis skills due to the wide range of virtual laboratory capabilities. Engineering students can also use Kuczmann and Budai's [13] research in the virtual laboratory to design placement-based control poles for typical control problems: inverted pendulums, Furutapendulums, cranes, balls, and beams. So, controller performance can be learned on real-life application models. Mathematical models and design controllers are presented and experienced in virtual laboratories.

Virtual laboratories provide practical experience provided in real-life simulations[14]. Students are accustomed to real-world electronic equipment, with simple equipment and components resembling a natural and effective laboratory environment for engineering students to study[15]. A virtual laboratory can facilitate students in learning the use of measuring instruments at home, in vehicles, and anywhere. Students can practice independently, thus improving their skills in using measuring instruments. With a virtual laboratory, students can simulate the use of measuring instruments correctly.

Students can learn what will be practiced anywhere, anytime, without being limited by space, time, and distance through virtual laboratory media.

This research aims to develop a virtual laboratory that can facilitate students in implementing Basic Electronic Engineering practices during the pandemic. Virtual laboratories are used as learning media that can be designed to be applied to a wide variety of technology products, one of which is smartphones. Game-Based Learning (GBL) mobile applications are built according to age and level of education and adapted to the development of curriculum and the demands of science and technology. Virtual laboratories as a learning medium can be developed and utilized following lecture design. Virtual laboratories enable creating a new, effective, and fun learning atmosphere to achieve learning goals.

Methods

This research method uses the Cross-Sectional Survey Design survey method described by Matthews & Ross[16]–[19]. for researchers where it is only necessary to collect data at one point in time. This cross-sectional design effectively collects data from people's current opinions and responses. Robson and McCartan [20] explain that the survey method is a fixed design first planned and implemented.

Data Collecting techniques

The questionnaire developed in this study consists of 36 statements that respondents or students must fill out regarding the use of virtual laboratory media in the experimental learning process of the Basic Electronic Engineering course. The number of respondents in this study was 37 respondents, but only 33 respondents filled out the questionnaire sheet. Questionnaires are

distributed through a google form by filling out questions provided by researchers to find out the success of virtual laboratory media in improving student understanding and learning

outcomes for practical courses in basic electronics engineering. The questionnaire indicator can be seen in table 1.

Table 1. Research Questionnaire Indicators

No.	Indicator	Item Number	Item Total
1.	interesting	1,2,16	3
2.	Easy	3,7,15	3
3.	Independent	4,5,6,8,9	5
4.	Flexible	10,11,12,13,14	5
Total			16

The assessment of the instrument used a 4 Likers scale analysis technique with a detailed score of 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree.

Data Analysis Techniques

The data analysis technique uses descriptive analysis with a percentage formula with the following formula:

$$P = \frac{\sum X_1}{\sum X_n} \times 100\% \tag{1}$$

Table 2. Assessment Criteria[21]

Criteria	Percentage
Excellent	90%-100%
Good	80%-89%
Enough Good	70%-79%
Less Good	55%-69%
bad	30%-54%

Results and Discussion

Based on the results of data analysis obtained from the questionnaire with a total of 33 respondents, almost 90% stated that the tendency is to agree strongly and agree with the existence of a virtual laboratory for

Information:

P = Amount or amount of percentage

$\sum X_1$ = The actual score total

$\sum X_n$ = The ideal score

The author explains providing criteria for the percentage of data obtained by giving the following assessment criteria in table 2.

learning the practice of Basic Electronic Engineering. The percentage of data questionnaire analysis results can be seen in figure 1.

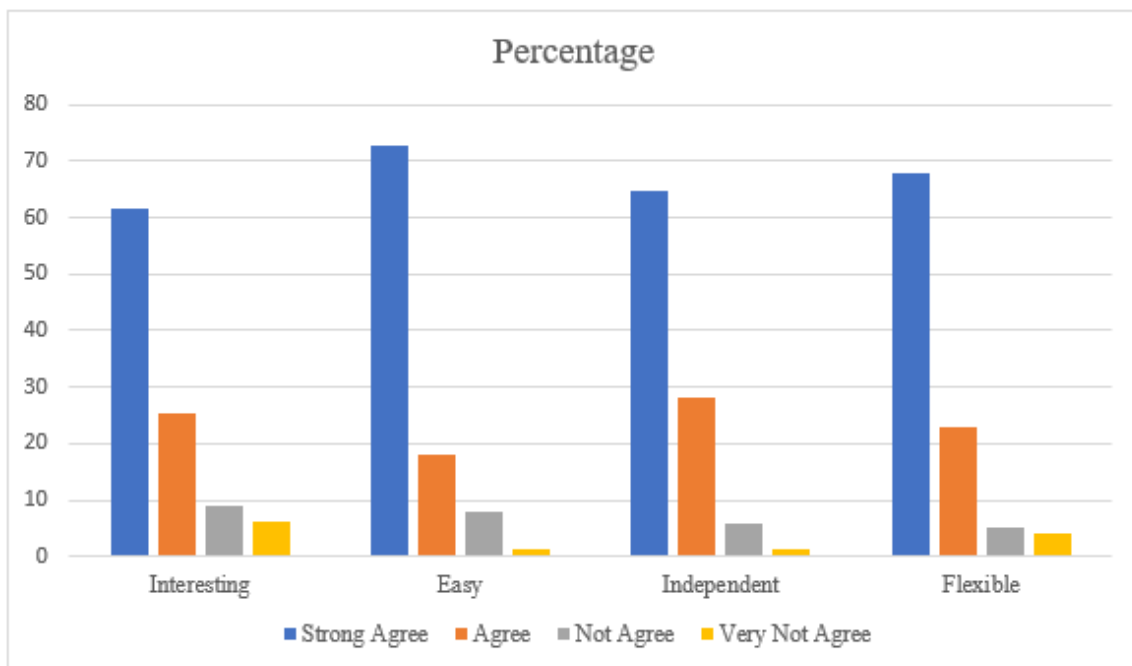


Figure 1. Percentage of Questionnaire Analysis Results

Based on the results of the questionnaire analysis, as shown in figure 1, it can be concluded that most of the attitudes of students strongly agree and agree with virtual laboratory media to improve skills in the practice of basic electronics engineering. From

the results of the semi-open questionnaire, out of 33 students, only ten people who subscribed to the internet at home used a provider, while the remaining 23 did not subscribe to the internet. Students who subscribe to the internet in megabits per second can be seen in table 3.

Table 3. Students Who Subscribe to the Internet

No.	Provider	Many	Megabit
1	Speedy		2
2	Indihome	5	
3	First media	2	
4	MNC PLAY	1	
1			

The virtual laboratory media used by students in this study was used to solve problems in the introductory Electronics engineering practice course using electronic component measuring instruments. By using virtual laboratory media, students can easily simulate the assembly of measuring instruments. Virtual media labs provide a hands-on learning experience for students without using real and

complicated equipment. Learning using virtual laboratory media offers a good starting point for collaboration and participation between students and other students and students and lecturers. The use of virtual laboratory media can be done by students anywhere and anytime, making learning easier to improve their ability to use essential electronics component measuring instruments.

The use of virtual laboratories as a learning medium significantly influences student success in practicing Basic Electronic Engineering courses. The virtual media laboratory can also meet students' individual needs and motivate them in essential electronics practice. The results of this study are in line with the results of Ambusaidi[14] research, which states that students have a comprehensive understanding and have a significant effect on their performance with the use of virtual laboratories[22]. Gerry[23] expressed his opinion about learning media, a physical means to provide convenience in delivering content or learning materials such as books, movies, videos, etc.

Furthermore, Gagne [24] states that learning media are all components of learning resources that can stimulate students. Reiser[25] also explain that media consists of chalk, whiteboards, textbooks, videos, tapes, recorders, computers, and overhead projectors, which can support success. Students in learning. This virtual laboratory media is designed to have advantages that can be used for learning activities, and this virtual laboratory media has the following benefits:

1. Students can use this virtual laboratory media can be used anytime and anywhere by students in simulations for measurement of essential electronic engineering components
2. This virtual laboratory media can provide convenient indirect learning without using natural and complicated equipment.
3. This virtual laboratory media can streamline the time used during the learning process, which is very effective in practical activities in the Basic Electronic Engineering course.

This virtual laboratory media also has disadvantages, namely:

1. This virtual laboratory media is used with the internet network; if inadequate, it cannot be used as a learning medium.

2. This virtual laboratory media is Android-based; it cannot be used if there is no Android media.

This virtual media laboratory is designed to meet the learning needs of students of the Electronics Engineering Study Program in semester 1, State University of Jakarta. Virtual laboratory media is developed based on the analysis of conditions in the field and makes it easier for students to practice Basic Electronic Engineering courses. Electronic Engineering students at Jakarta State University have high hopes for this virtual laboratory media to support success in practical learning activities of the Basic Electronics Engineering course. Based on a survey conducted by researchers, 90% of students strongly agree with virtual laboratory media as a means of practice rather than using highly complex equipment. Virtual laboratory media is also equipped with instructions for its use during the learning process to make it easier for students to simulate measurements of Basic Electronics components.

The use of Android-based virtual laboratory media facilitates learning activities. Still, it can also open opportunities for providers to provide the best service, starting from the application features offered to customers to promote and increase profits for them. The selection of relatively low prices will be an option for android users to enjoy the vastness of the internet network, which is very helpful and makes human work more accessible. In education, the internet network that some Indonesians can enjoy extraordinary supporting Grodotzki[26] in his research on virtual learning experiments in engineering education. The research results produced by the survey received positive feedback from students in the creation of a virtual laboratory carried out in the fall[27]. This virtual laboratory project is expected to enhance the

development of more experiments that support engineering education at the University of Central Florida. The Ministry of Education and Research in Germany (BMBF) cooperates with three universities in outstanding teaching, and the field of Engineering Sciences is the most extensive research. RWTH Aachen University, Ruhr-Universität Bochum and T.U. Research the University of Dortmund was previously a remote development center, and a virtual laboratory for mechanical engineering education focused on manufacturing technology. To cope with distance education, virtual and general virtual laboratories have been developed to visually conduct experiments in the laboratory [26].

Virtual media laboratories are also developed for problem-solving in building laboratory simulations for pneumatics. A simple experiment on a single-acting cylinder operated by a pneumatic switch. The investigation included the full use of Vive equipment, in which students were in a truly immersive 3D virtual reality environment, including the use of controllers to simulate natural environments[28]–[31]. Virtual laboratories provide solutions and are very helpful for Engineering students in overcoming problems in learning compared to conventional laboratories[32], [33]. The technology acceptance model is a theoretical model that is very useful in helping to understand and explain user acceptance of an online learning environment that combines virtual laboratories with practical work. The technology acceptance model also has a significant influence that has theoretical and practical implications in improving education and web-based resources[33], [34]. These studies also prove that virtual laboratory media is beneficial for student learning success. In addition to saving time, it can also keep costs from practicing with actual equipment. Virtual

laboratory media makes it easier for students to measure basic electronics circuits.

Conclusion

Based on the research analysis results, Electronic Engineering students about virtual laboratory media showed a positive response. However, some students did not subscribe to the internet in their respective homes. Virtual laboratories can facilitate self-study problems and make it easier to practice basic electronic engineering. Before the practicum activity is carried out, students can do a practicum simulation first. Students also feel happy and motivated by the existence of virtual laboratory media during the learning process during the pandemic. Not only during the pandemic / but virtual laboratory media can also be used face-to-face in practicum activities of the learning process, especially in introductory Electronics courses. This virtual laboratory media can be used anywhere and anytime without time restrictions with the internet network.

The implication is that virtual laboratories make it easier for students to do practicum during the COVID-19 pandemic. Virtual laboratories can improve students' skills in the field of basic electronics. Helps in self-study because it can be done anytime and anywhere, not tied to time and place. The novelty of the study is a virtual laboratory in the electronics industry. The limitation of this research is that the system developed is only based on Android. Students who do not have an Android system cannot take advantage of virtual laboratories, so conducting further research with a web-based system or multi-system is necessary.

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