Introducing Virtual Reality-based Virtual Laboratory for Electrical Engineering Education

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Abstract

The development of learning media has become an up-to-date issue in electrical engineering education. It involves analyzing virtual reality-based virtual labs for the Electrical Engineering Education Studies program aimed at facilitating the demand of the 4.0 era. Indeed, practicing 21st century skills focuses on ICT in education. Research Methodology used is a quantitative approach, and experimental research is used with the onegroup pretest-posttest design scheme. Implementation of creative thinking skills tests for pretest and posttest questions consisting of ten dual-choice questions according to high-level thinking skills criteria then tested Content Validity Index. In conclusion, the virtual reality-based virtual laboratory for the Electrical Engineering Education Study Program has a significant influence on student learning outcomes. In addition, it can upgrade the virtual reality based virtual laboratory for the major Electrical Engineering Education rating of 1.6 in the medium category.

Keywords: *virtual reality-based virtual labs; electrical engineering majors; learning outcomes.*

Introduction

The 4.0 industrial revolution calls for human centered society conceptual technology, artificial intelligence and human critical thinking, transforming the big data that the Internet of Things. However, the use of the Internet of Things is not evenly. This technological development has led Indonesia to follow that pattern, especially in the field of education. The term Internet of Things technology in the time of the Covid-19 pandemic has recently been popular to emphasize the vision of global infrastructure [1], connecting objects, using the same Internet protocol that allows them to communicate and share information. [2]. The Internet of Things applications have been used in various domains such as medical services, smart energy, customer service, smart homes, environmental monitoring, and education.

Increased use of IoT in education, especially in. It's important to incorporate these technological skills into the curriculum. In addition, these systems have different system functions such as sensing and decision-making can support and challenge the pedagogical process for all interrelated actors (faculty, students and staff) and all the assets involved (e.g. libraries, classrooms, and laboratories). [3]. IoT in education has two aspects, the first is its use as a technology tool to enhance academic infrastructure and the second as learning.

Electrical Engineering Education is a study programme that is closely related to experimentation or practicum. (Zwart, 2022). This practice is carried out in a laboratory,

where students acquire, train, and develop skills while learning to concrete abstract concepts [4]. In this program, IoT represents a new conceptual paradigm and is still in its early stages, the IoT as a learning or part of the learning material [3]. IoT learning is usually given only briefly, IoT material is general and there is no practicum [5]. However, due to the wide IoT coverage, learning IoT requires proper strategies and a deep level of material [6][7]. Thus, students can understand the concepts, uses, advantages and applications of IoT in a variety of fields.

In this study, IoT will be studied for practice in the lab. However, the limitation of the number of practicum tools has resulted in the use of hand-on labs for students experiencing psychological obstacles in carrying out practical work. Besides expensive in material procurement and operational costs as well as less. Practical objects or tools usually have large physical dimensions or are currently not readily available so it is difficult or not easy to present in front of the classroom. Internships in practical laboratories also make students less able to work because of the fear that the equipment used will be broken, as well as the fear of jeopardizing safety. The condition leads to a decrease in the student's learning motivation, thus affecting learning outcomes.

One of the most revolutionary tools that emerged during this rapid change is Virtual Reality (VR) [6]. This technology aims to provide a visual experience similar to the real world [8]. This technology helps create two- and three-dimensional images of abstract concepts from Electrical Engineering lessons [1]. The use of technology in the learning of Electrotechnology to support today's practicum is growing using virtual laboratory technology or E-lab based Virtual Reality (VR) [6]. The use of this virtual laboratory is flexible and can be used repeatedly by students and can also be used anywhere and anytime and is very useful for Engineering learning activities.

A virtual laboratory is a simulation of a practical laboratory packaged in a virtual form that runs using an electronic media device such as a computer or a smartphone[9] In today's technological developments, smartphones have become an important part of human life [6]. Android is one of the most widely used operating systems today [10]. Therefore, the open source license allows educators and students to access it more easily.

The Electrical Engineering Education Studies Program is one of the studies programmes of the Tarbiyah Faculty of Islamic State University of Ar-Raniry. The PTE Studies program is a major that has owned the Laboratory. However, today there are still many students who have not made the most of the VR Lab media [11] and Internet services in learning that have not been optimally utilized [5], have an impact on improving the effectiveness of learning processes and cause a lack of interest and motivation of students in the learning process [9][7]. Based on this background, this research is conducting research on introducing a virtual reality-based virtual laboratory for the Electrical Engineering Education major.

In the era of the 4.0 industrial revolution, the application of technology, especially virtual reality and the Internet of Things (IoT) is needed to improve the learning process and laboratory practicum. [5][4]. With VR technology in learning the Internet of Things, students can see, choose, and use sensor and actuator components [1]. Data already in the microcontroller by the student is then sent to the center device in the cloud [5]. One Android app works to access sensor data in the cloud. Besides being able to view sensor data, students can also control actuators with the Android app. VR-based IoT learning media is expected to increase the attractiveness of students to learn about IoT [12]. In addition, these learning media can improve the efficiency and effectiveness of learning IoT because there is no need to build or add physical facilities and facilities in the laboratory.

Method

This research uses a quantitative approach. It aims to test the effectiveness of the product by conducting experiments at UIN Ar-Raniry, Tarbiyah Faculty, Electrical Engineering Education Department, in Basic Electronics courses. Research methodology is a quasi-experimental research with one group pretest-posttest design, using One Group Pretest Posttest adapted from [13] as seen in table 1. This study uses One Group Pretest-Posttest Design. The entire population was given an initial ability test on VR-based IoT and then samples were randomly selected by sampling.

Group	*Pre-Test*	Treatment	*Post-tes*
Experiment (E)	O_1	X	O_2

Table.1 Design Experiment Quasi Group

Research on Introducing the Use of Virtual Reality-Based Virtual Laboratory for the Electrical Engineering Education Department of UIN Ar-Raniry. The subject of this study was 31 four-semester students who took a Basic Electronics course.

The questions used in the pretest-posttest are questions that think at a higher level in accordance with the learning demands of the 21st century. Subsequently, the results of the pretes-posts are analyzed using the N-gain test which is formulated as follows:

$$< g \geq \frac{s_{post} - s_{pre}}{s_{max} - s_{pre}}$$

No.	**N- *gain***	**Kategori**
1.	(<g>) ≥ 0,7	High
2.	0,7 > (<g>) ≥0,3	medium
3.	(<g>) < 0,3	Low

Tabel 2 N-gain value

Result

Table 1 presents data from virtual reality-based laboratory capability scores based on pre-test posttest results.

Data source	**Class**	
	Pre-Test	*Post-tes*
Min	20	60
Maks	60	100
Berarti	63,24	88,00
median	69,00	88,00
SD	17.643	12.617

Tabel 2 Virtual reality based laboratory capability data

Table 1 The results of the study showed the average score of virtual reality-based virtual laboratory skills far different. The average value of the student's information literacy skills pretest is 20, whereas the test results after being treated with virtual reality based virtual labs have the average information literature skills for the posttest is 60. The score is higher compared to the class not given virtual reality. Virtual lab based or conventional learning. Normality of student pretest and posttest can be seen in Table 4.

Class	**Shapiro-Wilk**		
	Statistik	**Df**	**Sig.**
Pretes	0,930	35	0,029
Posttest	0,913	35	0,008

Tabel 4. Normality Pretest and Post Test Students

Table 4 shows the pre-test and posttest values have significance values above 0.05 so the data can be said to be distributed normally. N-Gain Student Data Literacy Test Results can be seen in Table 5.

VR IoT pembelajar	**Uji Levene untuk Kesetaraan Varians**		**uji-t untuk Kesetaraan Sarana**		
	F	**Sig .**	**t**	**df**	**Sig .(2 − tailed)**
Varian yang sama diasumsikan	1.659	2.202	−5.009	65	0,000
Varian yang sama tidak diasumsikan			−5.009	65.104	0,000

Tabel 5. N-Gain Student Information Literacy Test Results

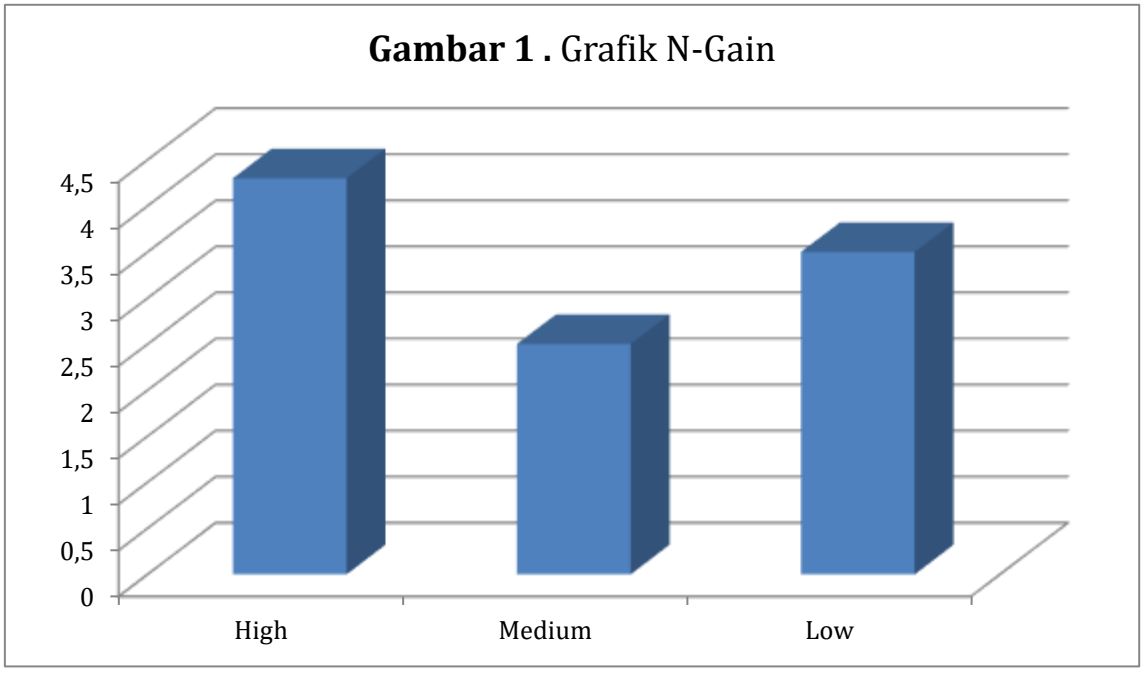
The same gain variance value is -5,009 with a degree of freedom of 65 and a value of significance of 0,000. Based on the table, the t value for df = 65 is 1,997. From the significance level of 1,997 < 0,05 it can be concluded that Ho has been rejected Ha has been accepted. Since Ho has been refused and Ha accepted, it is possible to conclude that there is an influence of virtual reality based laboratory capabilities on students of Electrical Engineering. N-gain data can be seen in Table 6.

Jumlah Sampel	N-gain rata-rata	Klasifikasi
25	1,6	Height

Tabel 6. N-gain data

Table 6 shows that the pre- and post-test results of 25 students experienced enhanced virtual reality-based lab skills. The results showed a n-gain of 1.6 in the highest category. This product is a virtual reality-based virtual laboratory media that is used in students of Electrical Engineering Education. This learning media is applied to the Internet of Things to support the skills of students in the 21st century and in accordance with the educational needs of the era of revolution 4.0. This media is developed through virtual reality. Learning media is a creative, innovative, and educational media that makes learning activities more conducive, interactive and enjoyable with equipped evaluation according to the indicators of HOTs virtual reality based laboratory. In addition, this media is also suitable for classes that are considered to be difficult for teachers to organize and fight, because with the presence of this media students become more calm and can follow learning with conduct. Therefore, this product can enhance the ability of virtual reality based virtual laboratory students of Electrical Engineering Education effectively and attractively to use in teaching learning activities because of using virtual reality. The entire virtual reality-based virtual lab has a n-gain student learning score of 1.6 in the high category represented in Figure 1.

Figure 1. N-Gain virtual reality-based virtual laboratory capability n-gain graph



The student's virtual reality-based virtual laboratory as a whole provides n-gain for student information literacy capabilities against UUD 1945 in the high category.

Conclusion

The results of this study concluded that learning activities using virtual reality based virtual laboratory for students of UIN Ar-Raniry University of Electrical

Engineering were performed very well. Improvement in the ability to use virtual reality-based virtual laboratories for students in UIN Electric Engineering Education Ar- Raniry University in the high category is 1.4. Significant improvement occurred in all sample classes. This shows consistency of improved ability of use of virtual reality base virtual reality laboratory of students of Electronic Engineering Education UIN ar-raniry University. The student's response to the application of the learning model of the classroom discussion received a good response from the student.

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