

## Developing an Online Learning Media Using Smartphone for the Electrical Machinery Course

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### ABSTRACT

This research is aimed to prepare a desktop-based learning media that can be used to support an online lab activities using android smartphones in Electrical Machinery Course at the Department of Electrical Engineering for the undergraduate level. This work uses a conceptual development model which integrates some sub systems of internet connection support, desktop computer, smartphones, induction motor application based on Matlab, and remote access application. Product testing was conducted through the online practical work activities involve 19 students of Electrical Engineering as research subjects. The product's performance in the presentation and instructional aspects was determined based on the research subject's perception, while the learning impact was determined using the portfolio assessment. The results showed that the research subjects give a positive perception of 81% and 82.2% for presentation and instructional aspects, respectively. This is indicating the product was easy to operate, interactive, informative, flexible, motivating, intriguing, and provide comfort to operate. The product implementation as an online lab activity media has also a positive learning impact, indicated by the mastery learning score of the students reached 84%. This product improves the performance of an existing induction motor simulator, which previously reported can only run offline and through this research it can be run online via smartphone.

**Keywords:** developing, online learning media, smartphone, induction motor practical work

### INTRODUCTION

The rapid development of information and communication technology has influenced many aspects of human life including education. As a result, there are currently at least four paradigm shifts in learning, ie: (1) from teacher-centered to student-centered, (2) from just delivering knowledge to the development of multi-context intelligence, (3) from limited place-based teaching to learning with global, local individual vision, and (4) from limited textbooks to diverse learning resources (Cheng, 2005). Even, in the lab activity, the impacts of the information technology development have changed the setting of laboratory landscape in the science and engineering education environment, from using a hands-on laboratory to information technology-based equipment through simulation (Lustigova & Lustig, 2009). The implications of this situation will demand the education world to be more adaptive in developing various learning tools and medias by involving information technology as its base so that the whole learning process can run more effectively.

In the department of Electrical Engineering, the learning processes of Electrical Machinery course currently have experienced several technical problems, especially limited availability in real tools that provides the support for doing practical work in high-power machines. This limitation is mainly due to the price of tools that is considerably costly. As the need for such teaching tool is urgent, any realistic solution has to be found by offering a simulation tool that is possible to support any lack of facilities. This tool is able to support the practical work using a virtual laboratory based on the information technology. Many research works have been carried out to perform the learning media using various simulation tools. The advantageous of this simulation is proven such of less time consuming, inexpensive, less space required (Chan & Fok, 2009). Also, the simulation offers an effective tool for increasing learning efficiency (Al-Zahrani, 2010), assisting students for improving practical work performance (Rajendran, Veilumuthu & Divya, 2010), strengthening the success of traditional learning (Rutten, van Joolingen & van der Veen, 2012), enhancing the understanding of practical work materials (Rahman, 2014), and giving the learning achievement better than real practical work (Muchlas, 2015). The other research work has found that incorporating virtual reality as a tool of simulation into the classroom for visualization of, and virtual training on, electrical equipment makes learning more interesting, motivating, and clear, and thus improves knowledge retention (Barata, Filho & Nunes, 2015). The application of virtual laboratory in the electrical machines practical work can improve students's lab-exams score and also can reach their opinions to a positive level of the relevance, usefulness, and motivational effect of the simulation

(Martinez-Roman et al., 2015). Through the practical work using a computer-based simulations, students became more interested in the power system protection course, praised the activities in the official evaluation reports, and were inspired to take their a final-year project, and also the number of students achieving high scores increased (Shahnia, Moghbel & Yengejeh, 2016). The selection of an open and portable environment for designing of the virtual laboratory allowed students to work autonomously, and optimized the use of lecturer resources (Gomez-Sacristan, et al., 2016). The current research has shown that the simulation especially in 3D-visualizations, can help students to understand basic control system concepts (Khan, et al., 2017).

Implementation of lab activities using virtual labs requires a simulator software as the main component. A simulator has been defined as a two-dimensional or three-dimensional interactive multimedia objects in digital heterogeneous form, consist of text, hypertext, sound, images, animations, videos and graphics that contain explicit and implicit learning goals (Budhu, 2002). Meanwhile, Merchant, et al. (2014) has defined a simulator is a device that provides an interactive learning environment that can imitate real life situations or processes.

Currently, smartphone apps that are largely used by students could be considered as a new format for supporting and enhancing the learning process in the higher education, as well as providing an online collaboration environment between the teachers and students (Vázquez-Cano, 2014). Through Wi-Fi connectivity and upload capabilities, allowing this tool will be able to support a learning media particularly in college (Khan & Chiang, 2014). Implementation of the mobile learning system based on smartphone to assist student learning had improved results on their final exams and gave a higher evaluation of the curriculum than those who did not (Wen & Zhang, 2015). The use of a simulator will offer more flexible operation when it could be accessed online via mobile devices or smartphones.

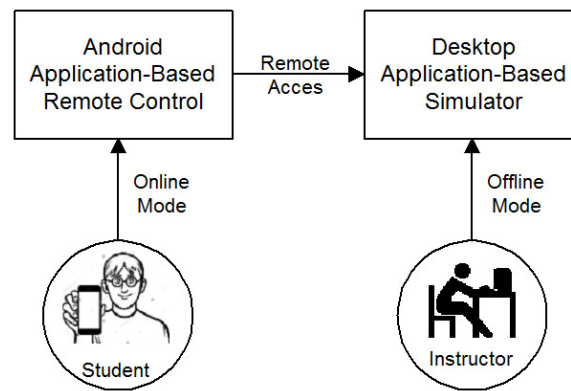
In the practical work of electric machinery, nowadays there are many simulation tools for simulating of the three-phase induction motor characteristic as has been developed by Renukadevi & Rajambal (2012), Arabaci & Bilgin, (2012), Shah, Rashid & Bhatti (2012), Boora, Agarwal, & Sandhu (2013), Nithin, Jos & Rafeek (2013), Kamal & Giri (2013), Leedy (2013), and (Rafeek, et al. (2013), but the simulators are a desktop application so that still running into not online mode. The research was carried out to develop a desktop-based learning media applications that can be accessed online through android mobile devices. This application will be used to support the online practical work of three-phase induction motors in Electrical Machinery course. There are many research works has been done for showing the advantages of online courses lab in the electrical engineering. Using the online mode in the control engineering course lab will be able to give a positive effect on student examination (Chevalier, et al., 2017), and in the analog electronics course, online laboratory can produce a positive effect in students' learning if an appropriate activity is used (Garcia-Zubia, et al., 2017).

The development of desktop applications into online applications can be done by combining the simulators (desktop-based applications) with Remote Control applications. Applications produced by Team Viewer company have provided free features for running remotely a desktop applications on a computer from other computers connected via the internet network. This model will produce a learning media that can be accessed online, even though the media is a desktop-based application. In this paper we will report a novelty of the three-phase induction motor simulator can run online via smartphone.

## RESEARCH METHOD

### A. Development Model

This study uses a conceptual model to direct the development process to produce a learning media that corresponds to the expected specifications. Conceptually, product components can be classified into two parts: the instructor and the student. The instructor component will serve as the host, meanwhile the student component as a client. The conceptual model of the media developed in this study is schematized as shown in Figure 1.



**Figure 1. A schematic diagram of Conceptual Model of the Media Developed**

According to Figure 1, it is shown that the simulator as a desktop-based application runs on an instructor's computer. Meanwhile, a remote control application runs on students's smartphone to access remotely the simulator. In this way, students will be able to run a desktop application which is running on the instructor's computer using the online mode via their smartphone. This model requires the availability of an internet connection with sufficient bandwidth, the remote control application based on both android and windows, as well as the simulator based on the desktop application.

#### B. Development Procedure

The development procedures carried out in this study follow the sequence of activities as suggested by Molenda & Boling (2008), namely: (1) do a need analysis of the simulator will be used as a learning media in the electrical machinery practical work especially in the topic of three-phase induction motor characteristics; (2) exploring the references and determining the appropriate type of induction motor simulator; (3) search and select the application program of remote access based on Windows and Android operating system as needed; (4) determine the specifications of a learning media to be developed based on needs analysis; (5) designing a conceptual model of media developed; (6) implementing a model of media developed using the support of internet infrastructure, desktop computer, smartphones, Matlab-based induction motor simulator application, remote access application based on windows and android; (7) evaluating performance of media developed by exploring user perceptions of media in presentation and instructional aspect, as well as determining the impact of media usage on learning.

#### C. Testing the Product: Subject, Data, Instrument, and Analysis

Through this research, product tryout is aimed to determine the performance of the media developed as a learning media especially for supporting the online lab activity of three phase induction motor characterization for students at the department of electrical engineering. The subjects of this study are students of the Electrical Engineering Department at Ahmad Dahlan University, who had taken Electrical Machinery practical work in the real laboratory. The number of subjects used in this research is 19 peoples. In this test, the subject performs a practical work procedure to find out the characteristics of a three-phase induction motor using a simulator that is accessed online from students's smartphone.

The data obtained is a quantitative score of the subject perception to the using of the developed simulator as a practical work media. This research uses questionnaire instruments include two major aspects ie the presentation and instructional aspects of the product. Perception instruments related to the presentation aspect of the product consist of five indicators: (1) ease of operation; (2) interactivity; (3) the readability of the simulator panel; (4) the readability of output graph; and (5) internet connectivity. For the instructional aspect of the product, the instrument contains indicators: (1) flexibility; (2) generation of motivation; (3) generation of interest; (4) improvement of understanding; (5) ease of use compared to the real laboratory; and (6) comfortability. Data analysis techniques used to present the subject's perception is the percentage with the criteria, the media has a good performance if the subject's perception score is above 60%.

This research has also measured the impact of media usage to the student learning achievement in the three-phase induction motor course. The learning impact is measured using a portfolio assignment instrument which produces the score in quantitative form with scale 0 up to 100. The criterion used in this learning impact test is media will give a significant impact if mastery learning of students at least reaches 75%.

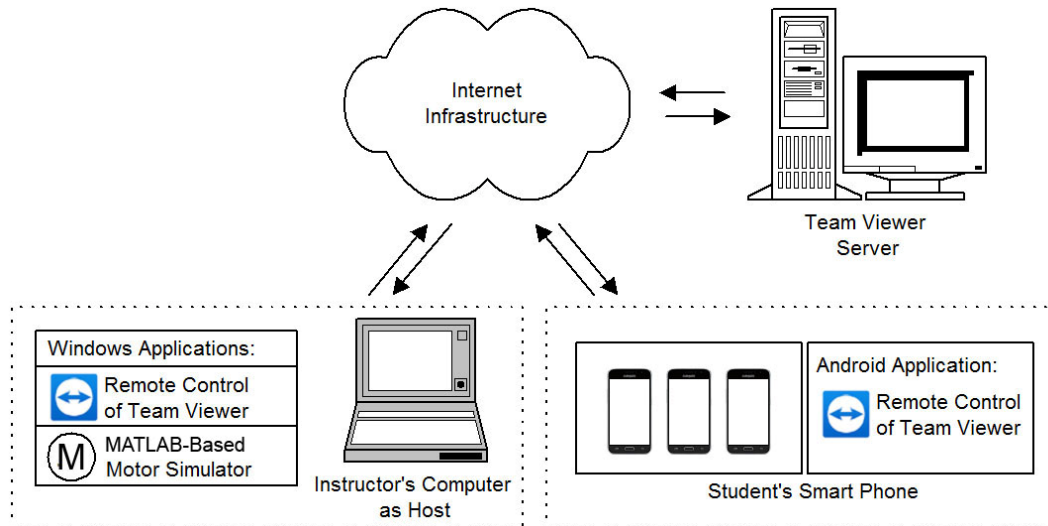
### FINDINGS AND DISCUSSION

This research has produced a desktop-based learning media that can be accessed online to support electrical machinery lab activities. From the experiment, this research has determined the software used to support the developed media as shown in table 1.

**Table 1. Software used in the media developed**

Name of Software	Source
Matlab-based induction motor simulator	Existing simulator
Matlab Version 7.0.4	The MathWorks, Inc.
Remote Control for Windows	Team Viewer
Remote Control for Android	Team Viewer

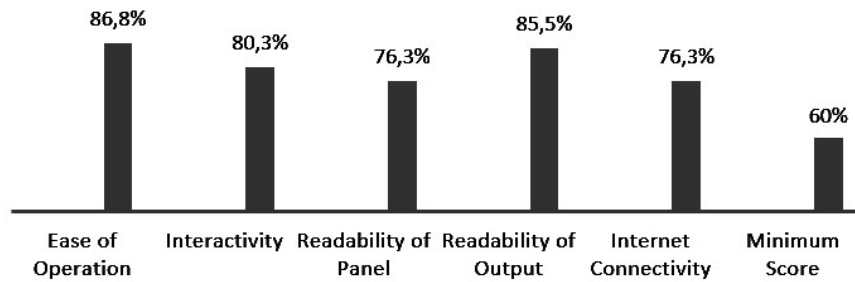
Selection of software as shown in Table 1 was done by considering various aspects such as funding, ease of operation, and the validity of the results. This product uses an existing induction motor simulator namely MOTORSIM, because it has been proven to provide a high degree of validity in displaying the results. Meanwhile, the remote control application is selected from the Team Viewer because it is not only easy to use but also this one is available in a free version so as to provide a low level of financing. Visually, the developed product implementation is shown in Figure 2.



**Figure 2. Implementation of the learning media developed**

The hardware used in this media are (1) desktop computer with Windows operating system as a host and run by an instructor; and (2) smartphones using the Android operating system as a client run by students. The operating procedure of the learning media model in Figure 2 can be described as follows: (1) instructor run Matlab-based motor simulator application and remote control application from Team Viewer on the host computer; (2) students run Android-based remote control application from Team Viewer on smartphone; (3) via messenger app like WhatsApp, instructor send ID and password to student's smartphone; (4) students enter the ID and password sent by the instructor to the Team Viewer application, so that they can remote access to the instructor's computer using the online mode via smartphone; (5) through smartphone, students will be able to run remotely the motor simulator application that runs on the instructor's computer. Through this way, students can do practical work using the online collaboration approach because remote access can be done by more than one smartphone as a client.

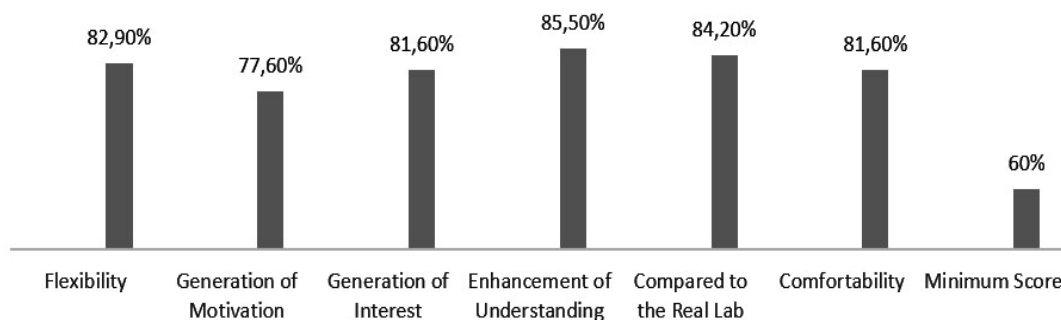
The perception of research subjects in the presentation aspect has been obtained with the results as shown in Figure 3.



**Figure 3.** Histogram of subject's perception in presentation aspects

By referring to Figure 3, it shows that the subjects give a very good perception of the product presentation with an average perception of 81%, more than the minimum percentage limit of 60%. This means the simulator developed provides a good presentation, high interactivity, ease of reading and understanding in the panels and output graphics, as well as for online mode the subject feels supported with the existing internet connection. Nevertheless, in certain cases, some research subjects have given a poor perception in the internet connection aspect. This is understandable because the internet connection provided for the smartphone is using data packets that at certain moments experienced connection barriers.

From the instructional perspective consisting of six indicators, the result of the subject's perception measurement is shown in Figure 4.



**Figure 4.** Histogram of subject's perception in instructional aspects

Based on Figure 4, it can be shown that the research subjects give a very positive perception of the instructional aspect of the developed product with an average perception of 82.2%, much greater than the minimum limit of 60%. In this case, the simulator can be considered as a learning media that is flexible, able to generate motivation and interest in learning, can improve knowledge, provide comfort and ease of use than tools in the real laboratory.

Results in Figure 3 and Figure 4 make it clear that students are interested using this system. Students interest in this learning approaches is a prerequisite for doing the online practical work effectively. By referring to the research results of Chevalier et al. (2017), this interest is due to students being able to setup the laboratory from their home or any where, rather than having to go to the real laboratory in campus. Beside that, students feels that the system has a highly speed loading, ease use, and rapidly time respons. Also, students have considered the system can reduce their travel time and it can make ease to choose the time slots of lab activity. This condition can be a capital to develop this system into a sophisticated online learning equipped with collaboration facilities as suggested by Muchlas & Novianta (2015).

Meanwhile, the study also found that subjects showed a good learning achievement in using this developed simulator as a practical work tool of the three-phase induction motor characteristics. After a portfolio-based evaluation, this research can show that 84% of subjects have achieved a mastery learning in practical work activity using this simulator, and only 16% of the subjects are can not achieve it. The mastery learning criteria are after completing the practical work using the simulator developed, the subjects can do the tasks well and correctly.

By referring to these findings ie the subject's perception of product presentation, the subject's perception of the product instructional aspect, and the impact of learning in using the product, it can be stated that the developed

simulator can be utilized as a learning tool of the three-phase induction motor characteristics in the department of Electrical Engineering, both academic or vocational program.

### CONCLUSION AND RECOMMENDATION

This study has produced a learning media that can be used to support online practical work activities especially in the three-phase induction motor characteristics topic. The product developed is a simulator of induction motor based on Matlab programming which can be accessed online through the smartphone. The characteristics of this product are easy to operate, highly interactive, and ease to read in the panels and output graphs provided. In addition, from the instructional aspect, to support the online learning, the product are flexible, able to generate motivation and interest, can improve knowledge, as well as provide convenience and easier to use than tools in the laboratory real. The product also has a positive learning impact as shown by the high level of student mastery learning achieved through the use of this media. A recommendation that can be given is this product needs to be used as a media in both a practical work or a learning with online collaboration approach for improving the learning processes to be more efficient, effective and flexible. This research has a limited of server availability, because this product uses a server from Team Viewer so we can not setup it as needed. For that, the next product is need to use the remote access server provided by own.

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