The feasibility of an android-based e-module to support learning PLC applications as controllers for automatic bottle filling and capping machines

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Abstract. The objective of this study was to determine the performance and the feasibility of an Android-based e-module to support the learning process of PLC applications as the controller of automatic bottle filling and capping machines in the competency of Electrical Power Engineering Skills in SMK N1 Pundong, Bantul. The method applied was research and development that refers to the ADDIE model from Branch. The results revealed that the developed Android-based e-module named PLC TOI Module in the .apkfile format, showed good performance indicated by all menus that function properly. In addition, the-e-module has a very high feasibility level to be applied in the learning process, proven by a combined score of 84.46% from the material and media experts' validation, and student's response.

1. Introduction

Now Vocational High Schools (VHS) cannot be separated from the influence of technological change and development. Technological development includes the development of communication technology in the form of smartphones. Most smartphones widely used are smartphones with the Android operating system. In December 2017, smartphone users with the Android operating system in Indonesia reached 88.37%, which means it was the most widely applied compared to other operating systems [1]. However, the use of smartphones among students still tends to be limited, as a medium of communication and entertainment, and can even lead to negative use.

Based on the observation in the competency of electrical power engineering skills in SMK N1 Pundong, Bantul, the students at the school did not used the smartphones as an e-module optimally. Smartphones are only used as communication and entertainment media. The use of smartphones in learning is still limited to search information through the internet related to learning theories and has not yet reached the practical side of the learning process. Therefore it is necessary to develop the functions of smartphones to be used as e-modules for students by creating e-modules based on mobile learning. It is packaged as interactive e-modules for students that can be accessed through the Android operating system.

Currently, the development of science and technology in the industry is very advanced. For example, in the electricity sector, the Programmable Logic Controllers (PLC) has been applied. PLC is increasingly used in the industry from time to time with more advanced and sophisticated format as the brain controlling various equipment or machines. In the third quarter of 2017, the food and beverage industries were able to contribute to the Gross Domestic Product (GDP) of the non-oil and gas industries by 34.95% or the highest compared to other sectors [2]. The production in the food and beverage
industries is carried out by production machines, one of which is automatic bottle filling and capping machines using PLC. Vocational High School as an educational institution that prepare their graduates to work in the industry should adapt with this situation. SMK N 1 Pundong Bantul as one of Vocational High Schools is working to equip the students with PLC competencies especially in the competency of electric power engineering expertise. PLC competencies are very important for the student. It will help the students to adapt with works related to the advancement of PLC technology in the industry.

Furthermore, the observations made on the implementation of PLC practices in the competency of electric power engineering skills at SMK N 1 Pundong, Bantul, showed that PLC practices are given through the subject of Electric Motor Installation in the fifth semester of the seventh grade. PLC practices were carried out using the trainer kit of Zelio PLC in 4 small sized groups. The learning process of PLC practice shows several points including: (1) only 1 or 2 students who were in front of the trainer kit were able to practice effectively, the rest were only watching; (2) the classroom were crammed of the group of students trying to use the trainer kit; (3) there are students in the group who are passive because they did not have any opportunities to use the PLC trainer kit; (4) the atmosphere of group practice is less comfortable; (5) it is often, the students did not share the PLC trainer kit with all of the group members and used it for their selves. The manufacturer PLC trainer kit is more suitable for individual practice, and is not suitable for group practice. However, due to the limited number of PLC trainer kits and the financial limitations of VHS to purchase PLC trainer kits, the implementation of PLC practices were conducted in groups.

To overcome these problems, it is necessary to apply an applicative PLC trainer kit in the industry such as an ergonomic z in learning PLC practices. In addition, it is also necessary to divert the use of smartphones for students from just for entertainment to something useful, namely to support learning PLC practices in the form of an Android-based e-module. Android-based e-modules using smartphones are suitable for students' self-study, especially in PLC programming and PLC hardware circuits through existing video facilities on smartphones.

The objective of this study was to find out the performance of the android-based e-module to support the learning of PLC applications as the controller of automatic bottle filling and capping machines. It was conducted in the competency of electrical installation engineering at SMK N1 Pundong, Bantul. In addition, this study was also aimed to determine the feasibility of the developed e-module to support learning of the PLC application.

A smartphone is a type of mobile application with the use of software designed to run on mobile devices. The use of mobile devices in Indonesia is always increasing every year. In 2013, 86.09% of Indonesia's population already had a mobile telephone. This percentage has increased from year to year and there has not been a decrease [3]. This indicates that most of the Indonesian population use mobile devices. It appears that the growth of smartphone users in Indonesia in 2013 reached 70 percent compared to the previous period. Based on this report, Android is an operating system that dominates the circulation of smartphones in the country with a market share of 59.91 percent.

A study related to mobile application-based information systems was conducted by Gao, Krogstie & Siau on adoption of mobile information services. This study examined the application of mobile information services at a Norwegian university, referred to as mobile services acceptance model (MSAM) [4]. The results showed that MSAM performed appropriately. The factors that have strong influence on the use of MSAM are the initiative and personal characters of the users. Other study conducted by Chiang, Yang, and Hwang on "An Augmented Reality-based Mobile Learning System to Improve Students' Learning Achievements and Motivations in Natural Science Inquiry Activities", which shows that the application of an augmented reality-based mobile learning system can improve students’ achievement. In addition, it was also found that students who learn using the learning system have higher motivation, attention, and self-confidence than students who study conventionally [5]. Lee, Han & Jeon studied on "Design of Small Sized Mobile Lecture Support System". The results included: (1) the system helps lecturers to manage the class without having to bring computer or laptop and interactions between lecturers and students happen easily; and (2) students can use this system anytime and anywhere by utilizing a web browser on a mobile device and interactions between lecturers and
students can easily occur [6]. Looking at the three studies, the use of applications included in the mobile application can facilitate educational activities. The three studies differ from this study in terms of the e-module material and the education level of the e-module users.

Other study relevant to information systems based on mobile applications, included, a study conducted by Kasahara, et.al. about "Evacuation support and safety confirmation of sharing in disaster situations for school trips by the mobile information system". The study resulted in: (1) a description of the mobile application system to confirm safety during school trips and shared information with relevant people; and (2) the mobile application system can facilitate rapid evacuation, save time and reduce students’ concerns about the situation [7]. Other studies were conducted by Chakravarti & Bhattacharyya on "Mobile Based Clinical Decision Support System". The study showed that mobile based clinical decision support system has good performance. The system also has solution used to meet service providers with full control of patient data equipped with warnings. Both of these studies are different from this study because they are not implemented in education [8].

2. Method
Data collection techniques and instruments used in this study consisted of: (1) in the needs analysis, the data were collected using a questionnaire, while the instruments used were questionnaires, (2) in the evaluation of needs analysis and design, the data collection technique used was observation, while the instruments used were observation sheets; and (3) in the performance testing, it was conducted validation of material experts, media experts, and students. The data collection technique used was observation, while the instruments used are observation sheets. The research data obtained were analyzed descriptively.

3. Results and Discussion
Through the development steps, the results that have been obtained was in the form of an android-based e-module to support the learning of PLC applications as controller of automatic filling and bottle cap machines that will be used for students in the electrical power engineering skills competency at SMK N1 Pundong. The development of the Android-based e-module was carried out using the Android studio application with some assistance from other applications. Android-based e-module products are in the form of a .apk file named "PLC TOI Module" which can be installed on a minimum of Android 5.1 Lollipop.

The Android-based e-module product has a main menu and several sub menus. In the main menu there are several sections that can be opened according to the user's wishes. These sections are the initial part, a learning module section consisting of seven buttons, a learning video, the choice to move to the discussion forum, the help button and about which are symbolized by the dot at the top right corner of the menu. In the main menu display there is also a slide image as a sweetener from the display. The initial part button is used to enter the prefix of the module, which consists of the cover of the module, introduction to the module, instructions for using the module, an overview of module learning, and basic competencies and subject matter modules. The learning module buttons is used to enter the contents of the module display and learning evaluation, so that the user can immediately answer a number of multiple choice evaluation questions contained in the module and see the value obtained. The learning video button help users to enter the learning video display which contains seven videos. The videos explain about the operation of the trainer as a whole, the programming of three trainer units, and the electrical installation of three trainer units. The discussion forum button functions so that users can discuss with each other related to material that is not understood and the teacher can also see what is discussed by students in the discussion forum. The three-point button in the upper-right corner of the main menu display contains two sub menu options, namely the help sub menu and the sub menu about the researcher. The main menu display can be seen in Figure 1.
The initial sub menu contains three parts, namely the cover, introduction, and advanced sections. The cover section contains the cover of the learning module. The introduction section contains the introduction from the researcher to the module user. The follow-up section contains three sub-sections, namely instructions for using the PLC practice module, an overview of the PLC's practical learning modules, as well as basic competencies and subject matter.

The learning module sub menu contains the materials and evaluation questions which are used as teaching materials for students. The first module contains PLC control system materials, the second module contains PLC programming materials, the third module contains PLC maintenance materials, the fourth module contains program transfer materials, the fifth module contains PLC operation materials, the sixth module contains PLC trouble shooting materials, and the seventh module contains PLC application material. In the learning module sub menu, each time the user opens the sub menu, a notification of evaluation results will appear. The notification display is intended so that each time the user opens the contents of the module, they are reminded whether the user has graduated or not on the relevant learning module materials. The display of the first module sub menu, the second module, and the acquisition of evaluation values are presented in Figure 2, Figure 3 shows the display of other learning modules.
Figure 2. Display of the first module, the second module, and display the acquisition of evaluation values.

Figure 3. Display of other learning modules

The learning video sub menu contains seven learning videos for users. The videos contain videos of the operation of the trainers, video programming from three trainer units, and electrical installation videos of three trainer units. The discussion forum sub menu helps users to discuss with each other if there is material that is not understood. In this view, teachers who have this application can also monitor what students are discussing. Users can create several discussion rooms that are tailored to the theme, so that in one discussion room can focus on one problem. The display of discussion forums can be seen in Figure 4.
Figure 4. Display of discussion forums

The help sub menu can be opened by pressing the dot symbol button in the upper right corner of the main menu and then selecting the help button. The help display serves to provide some explanation about the parts that are in the PLC TOI module application. The research profile sub menu can be opened by pressing the three-point symbol button in the upper-right corner of the main menu and then selecting the about button. This profile display of the researcher functions so that the user knows the brief biodata of the researcher.

To find out the performance of an android-based e-module product, named the PLC TOI Module, a black box testing need to be conducted. Testing was performed by running the PLC TOI Module on several Android smartphones with a minimum Android version of Android 5.0 with several repetitions. The results of an Android-based e-module performance called PLC TOI Module can be seen in Table 1.

Table 1. The Performance of android-based e-module "PLC TOI Module"

| Menu/Sub Menu                                           | Function (Yes/No) |
|---------------------------------------------------------|-------------------|
| Beginning Section                                       | Yes               |
| Cover                                                   | Yes               |
| Foreword                                                | Yes               |
| Lanjutan                                                | Yes               |
| Instructions for Use of the PLC Practice Module         | Yes               |
| General Overview of Module Practices PLC                | Yes               |
| Basic Competencies and Subject Materials                | Yes               |
| Module 1 PLC Control System                             | Yes               |
| Module 2 PLC Pemrograman                                | Yes               |
| Module 3 PLC maintenance                                | Yes               |
| Module 4 Transfer Program                               | Yes               |
| Module 5 PLC operation                                  | Yes               |
| Module 6 PLC Trouble Shooting                           | Yes               |
| Module 7 PLC application                                | Yes               |
| Tutorial video                                          | Yes               |
| Operation of the Trainer                                | Yes               |
| Electrical installation of Bottle Capping Unit          | Yes               |
| Bottle Capping Unit Programming                         | Yes               |
| Electric Bottle Filling Unit Installation               | Yes               |
| Bottle Filling Unit Programming                         | Yes               |
| Electrical Conveyor Unit Installation                   | Yes               |
| Conveyor Unit Programming                               | Yes               |
| Help                                                    | Yes               |
| About                                                   | Yes               |
| Discussion Forum                                        | Yes               |
Furthermore, the Android-based e-module product "TOI PLC Module" was validated by two material experts. The results of the validation of the TOI PLC Module product by two material experts are presented in Figure 5.

![Assessment per Aspect](image)

**Figure 5.** Validation of the TOI PLC Module conducted by material experts.

The Android-based e-module product "PLC TOI Module" was also validated by two media experts, the results of which are presented in Figure 6.

![Assessment PerAspect](image)

**Figure 6.** Validation of the TOI PLC Module conducted by media experts

Furthermore, an Android-based e-module product called the TOI PLC Module was assessed by a group of 4 students as users, the results are presented in Figure 7.

![Assessment per Aspect](image)

**Figure 7.** Results of assessment of the TOI PLC Module by students.

The developed product is an Android-based e-module application called "PLC TOI Module" with the Apk file format. The TOI PLC e-module module can be downloaded, then installed on Android smartphones and run according to its function and purposes. This application can be operated on Android with a minimum of 512MB RAM and a minimum of Android 5.0 Lollipop. The distribution of the PLC TOI module application is done using Bluetooth or other data sending applications available on Android devices.
An Android-based e-module product called the TOI PLC module has several advantages. First, the TOI PLC Module can be used personally and is flexible because it can be accessed directly on the user's cellphone. Second, the TOI PLC Module assists students to operate automatic bottle filling and capping machine trainers because it provides learning videos related to electrical installation, programming, and operation of the trainer. Thirdly, the TOI PLC module can maximize students in utilizing smartphones as e-modules in schools, especially in PLC Practice learning. Fourth, the TOI PLC Module is able to display the results of students’ evaluations after filling in the questions provided, so students can measure their level of understanding in each of the learning modules provided. Fifth, the TOI PLC Module is easy to use because of its simple features. Sixth, the TOI PLC module provides an online discussion forum so that students can interact with each other on matters that are not yet understood and in the forum the teacher can also monitor related content of the discussions conducted by students. However, the TOI PLC Module product still has a disadvantage of having a large enough file size because it contains several learning videos, thus taking up considerable space in smartphone memory.

Referring to the results of the material expert validation of the PLC TOI Module Products, it showed that the feasibility level of the Android-based e-module according to material experts was 66 out of a total ideal value of 80, or 82.5% which was included in the very feasible category. Validation conducted by media experts obtained ideal data criteria for media expert evaluation of the PLC TOI module that is equal to 54 of the total ideal value of 68 or 79.41% included in the feasible category. The assessment made by students as users of the PLC TOI module is 130 out of a total ideal value of 148, or 87.83% which is included in the very feasible category. If the validation scores of material experts, media experts and student evaluations of the Android-based e-module product are combined then a score of 250 is obtained from an ideal maximum score of 296 or 84.46% which is included in the very feasible category.

4. Conclusions
An Android-based e-module have been produced to support the learning of PLC applications as the controller of automatic bottle filling and capping machines at SMK N1 Pundong Bantul, named "PLC TOI Module" with the .apk file format which has good performance, indicated by all menus can function properly.

The Android-based e-module have been produced to support the learning of PLC applications as the controller of automatic bottle filling and capping machines at SMK N1 Pundong Bantul. The developed e-module was feasible indicated by a combined score of material experts, media experts and students’ ratings reached 84.46%.

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