‘Electree’ as Android Mobile Learning Application based on Arduino Projects for Junior High School Students

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Abstract. The advanced technology connects a mobile learning application with the Arduino UNO for science learning. The work aims to develop ‘Electree’ as a new android mobile learning application based on Arduino projects for junior high school students. The method used in this research was descriptive. The participants were 22 students of private Junior High School in Bogor and three science teachers from each respectively Junior High School in Bandung and Bogor. The experts have evaluated content, language, and media in the mobile learning application. The results show that the overall mobile learning application based on Arduino UNO is adequately received a very good evaluation from each aspect. The students and science teachers are greatly welcomed for its implementation.

Keywords: STEM Learning, STEM Literacy, Arduino, Protoboard experiment, Electricity

1 Introduction

The 21st Century marked with a lot of technology used in every daily activity in our generation nowadays. Students consider that the function of using mobile to their learning is more productive [1]. The rapid development of technologies is one reason that makes ICT (Information and Communication Technologies) has an essential role and function. The application such as education software is used in the education field and creates an exciting presentation that can attract students’ interest to come, explore, and decide to follow the rule of the system to get the information needed [2]. Nowadays, learning science with Arduino becomes a breakthrough and peculiar topic to be discussed [3],[4]. The mobile learning is expected to lift difficulties of students in studying formally only in class, the access to mobile learning application build students’ learning experience everywhere and every time it is.

Nevertheless, this far, none of the mobile learning applications are specially designed to assist learners in learning electricity with Arduino UNO projects. To make students both comprehend and apply the knowledge, suitable, flexible, and testable learning are needed. To visualize complex concepts, mobile learning is expected to be a solution. Bekker, Bakker, Douma, Van Der Poel, & Scheltenaar [5] argued that by using digital toolkits such as mobile application to teach children about science is help for their 21st Century skill improvement which includes ICT and information literacy.

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Mobile learning intervention (MLI) give influence mostly too difficult multiplication test items and found it to be statistically significant. Mobile technologies are relevant for learning and education itself can potentially transmute to be contextual fit and socially implemented for learning. Mobile technology can give positive impact if it design, implement, and develop properly to catch up with a 21st-century era where digital era is required in an education environment to make it available anywhere, anytime, for anyone, and affordable cost [1].

Arduino Uno is a perfect platform for a series of lab settings. The tests reported presently indicate excellent reliability in controlling the parameter that will be used. Arduino Uno proved that with simple programming, various equipment can be built [6],[7]. Arduino Uno has limitless possibilities to be used as a learning tool and develop many ideas for the lesson. The Arduino project was developed in an educational setting. This makes it ideal for newcomers to get started quickly.

One of the topics in physics that students find prevailing is electricity. In the previous research, Ergin & Atasoy [8] explained that abstract concepts in electricity such as current, potential difference, resistance, power, electrical potential derive from the charge, short circuit and the properties of the electrical circuits are often mixed up and resulted in the misconception among these concepts. One of the misconceptions that students commonly stated is about current; students often think that current is an energy or force that moves through a wire. Electrical components and circuits are related to each other; students generally believe that all current and voltage in series and parallel circuits are the same. This problem arises because of the misconception and lack of real visualization of the concepts. Consequently, this paper proposes a tool which combines Android mobile learning application with Arduino UNO projects. This application is named 'Electree'. It is not only provided with materials about electricity but also sequencing projects using Arduino UNO completed with a quiz. This application will be developed by considering experts' evaluation, science teachers' feedbacks, and Junior High School students' responses.

2 Research Method

The research method that will be used in this research is descriptive research. According to Fraenkel, Wallen, & Hyun [9], a descriptive study is meticulously and carefully described how a phenomenon of affairs state is happening. The method that is used is a survey method that requires a questionnaire as an instrument to collect the data that can be explored not by judging or interpreting. This research method is suitable and appropriate to the objectives of the research which is to develop and validate how mobile learning based on Arduino projects in Junior High School students.

The researcher created mobile learning in the form of an Android application in a dynamic electricity topic based on Arduino. Final paper supervisors then supervised the mobile learning application before the experts that expertize in content (Physics), language (English), and design (IT) assess it. After a sequence of suggestions and revisions until the final assessment, the mobile learning application was brought to students to be reviewed. The subject of this study was three experts in each aspect: science content, language, and design for mobile learning application validation. Those experts that already have a background based on what they expertise will assess these aspects. For mobile learning application impressions, Junior High School students will assess the media.

The location of this research is Private Secondary School "X" in Bogor. The school uses English as the communication and delivery language in the teaching-learning process. The curriculum that applies in this school is National Curriculum which is Curriculum 2013 and Cambridge International Syllabus. These curriculums are applied for all grades of secondary school in both lower and higher secondary schools. The population in this research will be the students of this Junior High School in Bogor. The sample will be 15 students from Junior High School in Bogor who will be chosen through simple random sampling.

The instruments are used to obtain or gain the data in this research. To measure the suitability of mobile learning application and how its design met students' actual necessity of comprehension in learning dynamic electricity topic, the instruments that used are experts' judgment rubric and questionnaire for students and science teachers. The rubric used in this research is the Likert scale and ratings. The rubric was including two aspects: the techniques of making mobile learning applications and characteristics of it. The features are the content, whether it is the electricity topic or the Arduino projects, the language, and the design of mobile learning itself. The scale is 1 to 4 to determine if the points in mobile learning application were met the intention, goal, and expectations. The Likert scale and ratings are also used for student's and teachers' questionnaires. There was a 4-rating scale to determine whether the mobile learning application is compatible and suitable for Junior High School level or not. The elaborated scoring for the rating is in the form of a questionnaire.

3 Result and Discussion

3.1 Design Stage

The materials that contained in mobile learning application based on Arduino projects are electricity topic which specified in Cambridge syllabus and Indonesian Curriculum 2013. In this mobile learning application based on Arduino projects, the materials divide into some issues which are Electrical Quantities, Electrical Components, and Electrical Circuits. The contents are deciphered in the teaching-learning process.

The flowchart is the illustration of story flow in the development process of mobile learning applications based on Arduino projects. The flowchart is started from the initial process of using the mobile learning application until the end by the user. The storyboard is the plan of multimedia that will be developed based on the flowchart to make the development stage easier. **Figure 1** is the example of a storyboard from a mobile learning application based on Arduino projects. On the first page show the menu to sign up and log in for the user to use the app. After the first page, the menu feature is shown and the user can choose the content. The sidebar menu is also provided.

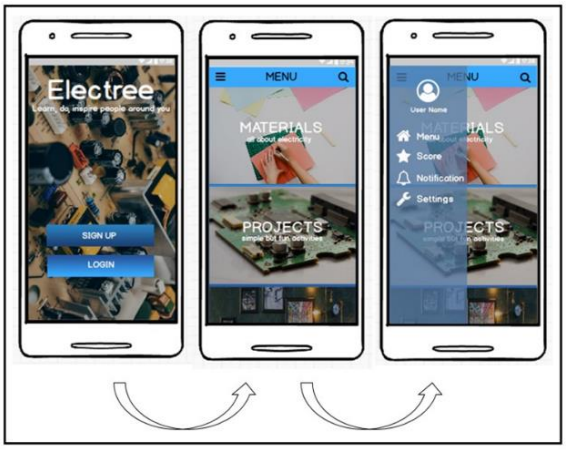

Fig. 1. The example of a storyboard scheme.

3.2 Development Stage

The interface was made based on the storyboard in the design stage. In this process, First, collect the user necessities and define the design conceptually, and then validate it. After that, the problems that arise should be fixed before it can be developed. **Figure 2** shows the flow and display of a mobile learning application based on Arduino projects.

To check the app's suitability, some experts are involved in judging the app as seen in Table 1. The experts are two experts in materials' content, three experts of language, and three experts in media (IT). Based on Table 2, the average percentage of judgments on content is 83.335% which can interpret as the "Very Good" category. The overall score of content judgments is concerned with the content presented in this mobile learning application. The materials are already adequate for Junior High School students who study dynamic electricity based on the IGCSE curriculum. The interest of contents that distinctly present from a usual textbook can boast students willing to consider quite difficult material differently. It can be seen by the percentage that given by experts both in accuracy and interest of contents that the contents offered in the application follow the curriculum and syllabus used in Junior High School that proper for their study.

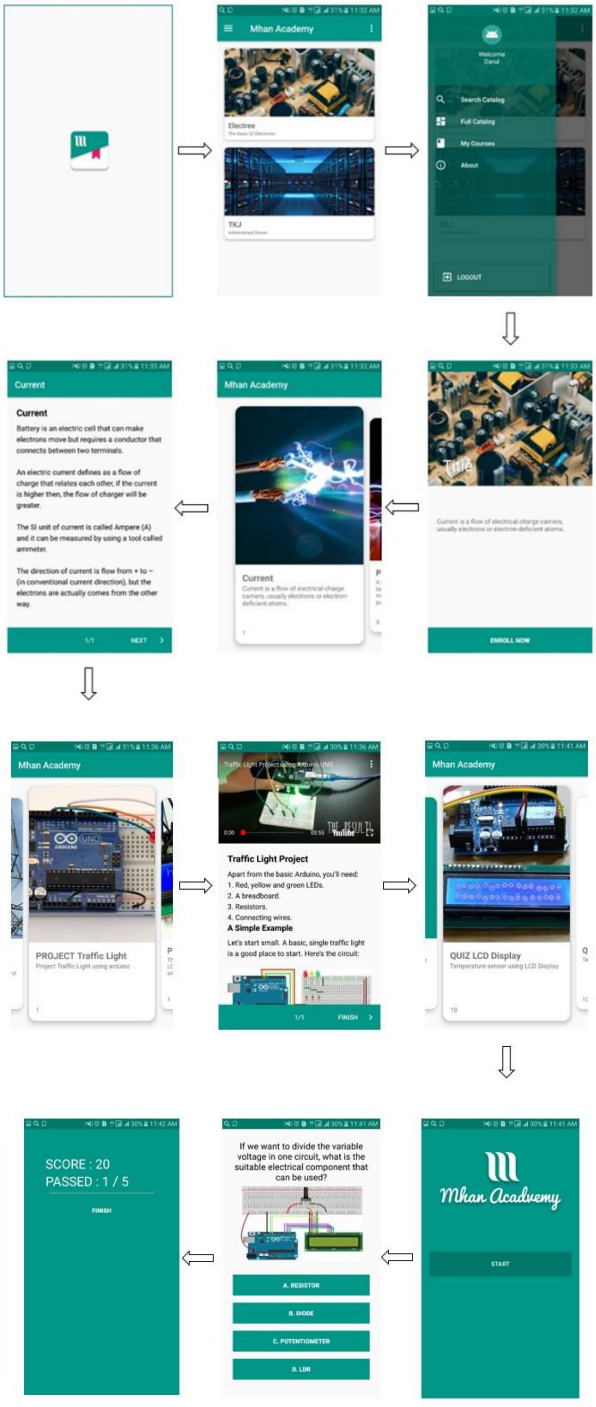

Fig. 2. The interface of mobile learning application based on Arduino projects.

Table 1. Experts' judgment result on content.

No.	Expert	Aspect	Ideal Score	Result Score	Percentage (%)
1.	First Expert	Content	4	4	100
		Accuracy	4	4	100
		Interest	4	4	100
		Average Score			100
2.	Second Expert	Content	4	2	50
		Accuracy	4	3	75
		Interest	4	3	75
		Average Score			66.67
			Average Score of All Experts' Result		83.335

3.3 Implementation Stage

Based on the result in Table 2 about the comparison result of each aspect based on science teachers' and the student responds, there are some aspects categorized as "Very Good" scale that has percentage range from 76%-100%. The aspects are mobile connectivity with 83.30%, projects with 83.30%, a quiz with 91.67%, and personalized learning experience with 83.30%. The materials and mobile layout of application consecutively scored 66.67% and 75%to which classified as "Good". The overall response from the teachers is positive which is to support the mobile learning application to be used in the teaching-learning process.

The highest percentage is for the quiz given after to do projects; it is stated that the exam can enhance students' comprehension of materials. One science teacher said that,

"The materials given are understandable and it is useful for project-based learning. It also helps students to study easily because the application can be accessed by students anywhere and anytime."

the application generally helps students to give them more meaningful learning. One student stated that,

"The application gives valuable information accessible. The materials also easily explained."

The Arduino project helps the student to visualize and creatively imagine how the concepts of electricity are implemented on it. D' Ausilio [10] researched that the Arduino Uno is a perfect platform for a series of lab settings. The tests reported presently indicate good reliability in controlling the parameter that will be used. Arduino Uno proved that with simple programming, various equipment can be built. In this mobile learning application, students can study how the projects using Arduino be done and how the concepts of electricity are implied to it. The science teachers noted that this mobile learning application creates a better-personalized learning experience for students; the evaluation shows 83.3% out of 100% that categorized as "very good."

The overall evaluation score of a questionnaire filled by students is 87.9% out of 100% scale that indicates a "very good" evaluation. Students found this mobile learning application is easily accessible and help them to study at home. Kiger, Herro, & Prunty [1] stated that mobile technology could give positive impact if it design, implement, and develop properly to catch up with a 21st-century era where digital era is required in an education environment to make it available anywhere, anytime, for anyone, and affordable cost. Students found this mobile learning application is exciting and help them to construct their understanding of electricity concept and the projects of Arduino itself.

Table 2. The result of science teachers' and students' responses to Electree.

Category	Statement	Teacher score		Student Score	
Mobile Connectivity	The application was a convenient and sufficient time to consume. Easy to connect. The materials are accessible.	83.3	Very Good	87.9	Very Good
Materials	Materials are understandable	66.7	Good	81.8	Very Good
Projects	Projects are attractive, challenging and improve the understanding	83.3	Very Good	85.2	Very Good
Quiz	The question in the exam can enhance the comprehension	91.7	Very Good	90.9	Very Good
Mobile Layout	The appearance is attractive. All text is seen and readable. All media are supported the material comprehension.	75.0	Good	95.9	Very Good
Personalized Learning Experience	Mobile learning application is such a meaningful learning Gives advantages to create personalized learning	83.3	Very Good	95.5	Very Good
	Overall	80.6	Very Good	87.9	Very Good

Aside from what the experts had been evaluated, science's teacher responses and Junior High School students' responses, the prospect of this mobile learning application is generally welcomed. They gave positive evaluations towards this mobile learning application as it is seen in their answer to the rubric and questionnaire evaluation. Students generally responses that mobile learning can make their study easier especially outside the class learning. Mobile learning is one of the frameworks in achieving maximize students' learning by easy devices and applications that can be identified at a right time, the right place to promote digitally-rick curricula that suitable for all education [11]. The accessibility and easiness of mobile learning applications can be taken as the strength despite the weakness also still present such as the connectivity and the revision of the material. According to the result and analysis of experts, science teachers, and Junior High School students toward this mobile learning application, it is evidenced that mobile learning applications can gain their interest in learning electricity and make them willing to use it in science class. Therefore, the real implementation of this mobile learning application as an enriching source besides the main textbook will bring some advantages to the learning process. The use of M-learning declares various chances to engage a set of knowledge widely, context construction beyond the formal educational set up [12]. Therefore, the implementation of this mobile learning application in the future is predicted to facilitate the teaching-learning process.

4 Conclusion

According to all evaluations conducted by experts, science teachers, and Junior High School students, this mobile learning application 'Electree' has received positive responses.

All features proposed in the mobile learning application are helpful since they are perceived as useful and frequently used by students. For future work, the upgrade version of this application has to build with includes precious materials and a better flow of learning delivery.

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