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EduKits 4.0 for Learning Solar Power Energy Conversion on Junior High School

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Solar cells are being widely developed in various applications such as power plants, street lighting, battery replacements on portable devices, and so on. But its use in daily life in Indonesia is still minimal. This is because public understanding about solar cells, in general, is still lacking. Therefore, there needs to be an effort to educate the public about solar cells so that this technology can be used as part of students' learning from an early age so that the future generations can properly utilise solar cells; so that they are also inspired to develop them with more innovation. But learning about solar cells in schools is still very rarely done because of various factors including lack of learning devices about solar cells that are systematic and appropriate to the level of development of students, teacher competencies that have not received sufficient stock about solar cells, and most of the literature is in foreign languages. Therefore, it is necessary for learning tools that make it easier for teachers to teach the students. In this paper, we proposed an Edukit 4.0 as a learning tool for the junior high school level that is easy to understand, interesting, and a measurable evaluation system. The

EduKits 4.0 is equipped with smartphone apps to provide visual interface for experiments and learning in the education 4.0 environment. The obtained results show the positive gain in learning experiences for students.

Keywords: *EduKits 4.0, education 4.0, smart apps, solar cell*

1. Introduction

Science learning in junior high schools is directed at mastering the concepts of science in-depth and its application in everyday life. Science means asking questions, seeking answers, understanding answers, perfecting answers both about natural phenomena and the characteristics of the environment through systematic means. In studying sciences study materials, it is necessary to assist in developing a number of scientific skills or scientific work, through scientific methods. Science knowledge is the basic knowledge of Industry 4.0, especially on solar cell learning materials. Solar cells or photovoltaic cells are a semiconductor device that consist of a large region of diode p-n junctions, where, in the presence of sunlight, they can create useful electrical energy. This change is called the photovoltaic effect [1]. To adapt learning with the Industrial Revolution 4.0, an educational revolution is needed, namely education 4.0.

To support the implementation of the curriculum 2013 and education 4.0 for junior high school especially in science lessons it is necessary to make preparations such as tools and teaching materials. Solar cell study materials are still relatively new in junior high schools in the curriculum for 2013, so it is necessary to develop an appropriate solar cell learning tool. Based on these facts, this study wanted to develop EduKits 4.0 for solar cells in accordance with the curriculum for 2013 and education 4.0 in junior high school. The EduKits 4.0 of solar cells is equipped with smartphone apps to provide visual interface for student's experiments and learning in the education 4.0 environment. The preparation of teaching materials in the learning process is done as an alternative to improving student learning achievements.

The problem in this study originated from people's lack of understanding of solar cells so that their use in everyday life is still small. Learning about solar cells in schools is still very rare, this is due to various factors, including that there are no systematic and appropriate solar cell

learning devices at the junior high school level, teacher competence that is not yet adequate for solar cells, and much of the literature is in foreign languages. Other than that, people's understanding of the Industrial Revolution 4.0 is relatively low whereas Industry 4.0 needs a workforce that matches its specifications, and junior high school students will become workers in the future. Therefore it is necessary to develop learning tools that facilitate teachers in teaching to students and in accordance with the understanding of the Industrial Revolution 4.0.

The purpose of this study is to make learning devices about solar cells at the junior high school level that are easy to understand, interesting, with a measured evaluation system and in accordance with the Industrial Revolution 4.0 through education 4.0. The urgency of this research is to instill understanding of the Industrial Revolution 4.0, especially in the learning of solar cells in junior high school students, so that future generations can have the ability and knowledge of solar cells in accordance with the needs of the industry in his day, in addition, students are expected to develop their knowledge in an innovative way

2. Related works

This research has the significance of knowledge and technology aspects that are easily understood by teachers and junior high school students, presented in Indonesian, and the practice of simple words that are easily translated and understood by students, thus stimulating them to work to develop solar cell applications in the future. The existing EduKits are mostly in foreign languages.

Several references are used to support this research. The references are about education 4.0 in learning solar energy systems using EduKits.

Table 1 Related Research to Education 4.0 of EduKits Solar Energy Systems

Reference	Problem	Method	Result
[2]	Adjustments to education in Industry 4.0	Develop an innovative curriculum	Connected students' skills to digital enterprise and Industry 4.0
[3]	Impact of Industry 4.0 to education	Analysis of Industry 4.0 to higher Education	Involvement of higher education in Industry 4.0 in being able to adapt to future technologies
[4]	Solar panel control in different ways	Designing solar panel control used PLC, SCADA or microcontroller	Skill and knowledge increase about series or parallel connection of solar panels and how electric energy obtained
[5]	EduKits for solar energy systems	Develop a buck converter with MPPT for solar energy systems	Solar energy systems used a buck converter with MTTP and increase students' comprehension
[6]	EduKits for laboratory photovoltaic systems education	Develop a solar system EduKits	EduKits is used for teaching purpose and allowed students to experiment with different type components

Author [2] developed an innovative digital manufacturing curriculum for Industry 4.0, where the curriculum provided the basis for implementing digital twins and supported student training so that students' abilities are connected to digital enterprise and Industry 4.0.

Author [3] analysed the impact of Industry 4.0 on higher education, the results show that Industry 4.0 influences learning styles in higher education and being able to adapt to technological developments in the future.

Author [4] designed a solar panel control, in different ways such as PLC, SCADA or a microcontroller and with series or parallel connection. This research is used for education, so

the students can see how electrical energy is obtained from the panel and increases the skill and knowledge about a solar panel system.

Author [5] developed a solar energy system that used a buck converter with simple Maximum Power Point Tracking (MTTP) that helps students to understand the solar energy systems concept and become an effective learning tool.

Author [6] developed a solar system EduKit that can be replaced to a different type of solar panels, charge controllers and inverters in purpose for solar energy systems learning and the variety of data displayed on the LCD screen.

Based on these references, educational tools or EduKits are required to support the implementation of education. In this research, EduKits 4.0 are made with specifications that fulfill the needs of Industry 4.0 concepts. This EduKit is also used in conjunction with PBL (Problem Based Learning) models. There are some references that use EduKits especially EduKits of solar energy system, but the differences are those EduKits not classified for education 4.0 and the EduKit forms are limited to tools without flexible monitoring and do not reflect Industry 4.0 concepts. For example, look at Figure 1.

Figure 1. Solar Robot Kit

In Figure 1, is a solar robot kit, where the solar cells are used as a power source to run the robot. But as shown, this EduKit only serves to show how the robot works with solar cell power

sources and that there are no robots monitoring or controlling via a smartphone or anything else.

Figure 2. Solar Tracker Kit

Figure 2 is a solar tracker kit designed to automatically track the sunlight from any direction. But, this solar energy system kit does not have monitoring or controlling systems connected to a smartphone or others.

3. Methodology

The smartphone application is made with flutter SDK developed by Google. The display parameters related to solar cell monitoring, include voltage, ampere, and power graphic. These three parameters are used to analyse the energy produced from solar cells and used by loads.

This research used the ADDIE model as a research method. The ADDIE model is an approach that helps instructional designers, any content developers, or even teachers to create an efficient, effective teaching design by applying the processes of the ADDIE model on any instructional product. The acronym ADDIE stands for the important components in the process of creating the instructional design, which are Analysis, Design, Development, Implementation, and Evaluation [7].

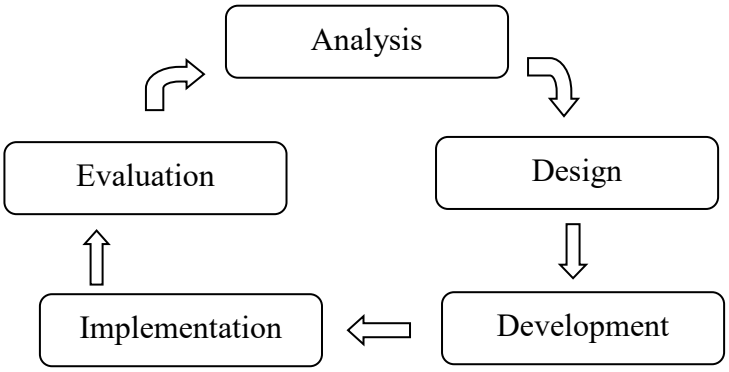

Figure 3. ADDIE models process

The Figure 3 ADDIE models process shows how this EduKit was developed. The methods were divided into several steps, they are:

3.1 Analysis

In the analysis phase, the first thing to do is to analyse the student's initial knowledge and abilities, then analyse the main objectives to be achieved by students. then develop how to achieve these goals in a structured manner.

In this study the initial ability of students regarding solar cells is still relatively low, this is known from interviews conducted with teachers and students. So it can be analysed so that the objectives to be achieved are that students can understand the concepts and materials of solar cells. Matters that support the achievement of these objectives are adequate instructional media, good preparation of learning and the appropriate ability of teachers.

3.2 Design

In the design phase, what has been described in the analysis phase is developed in more detail. How to design it effectively in order to educate students. This research chose to design EduKits which can make it easier for students to understand learning about solar cells.

3.3 Development

In this development phase, the researcher works on a design that has been created, where the parts of the EduKits are configured so that they can work in accordance with the original purpose of the study

3.4 Implementation

In this study, the implementation of EduKits that had been developed only reached the experimental stage by experts. In the future, it is hoped that research can be continued with the application to junior high school students.

3.5 Evaluation

The final process in the ADDIE model is the evaluation phase, wherein this study the EduKits developed went according to their function according to judgment experts. So hopefully these EduKits can be applied in learning solar cells in junior high school.

4. Result and Analysis

The EduKits 4.0 for learning solar energy are equipped with smartphone application that display learning and monitor solar cells which are easier for students. In Figure 4 is a display of the developed smartphone application. Figure 5 shows the hardware simulator of the Edukits that are developed.

Figure 4. Display of Smartphone Application

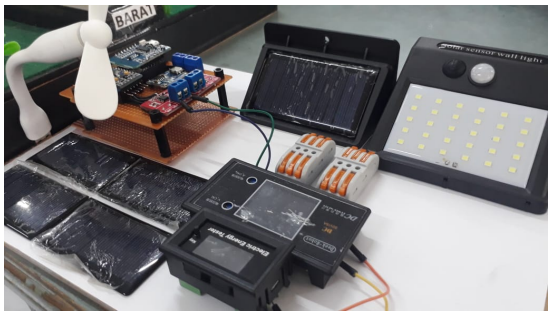

Figure 5. Hardware Simulator Solar Cells

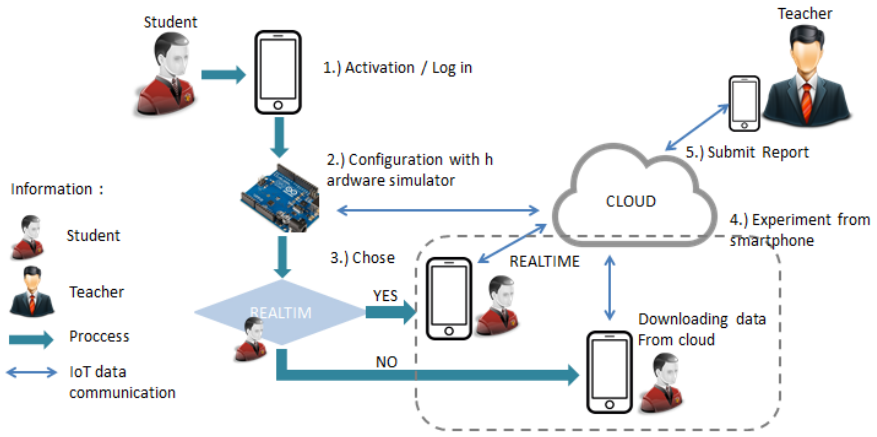

Figure 6. Functional Diagram

Figure 6 shows how to use the EduKits 4.0 for learning solar energy. At first, students need to activate an account or log in to the application. After that, students can select to monitor, do an assignment or read solar cell theory. Teachers can monitor students working on assignments and studenst who log in to the application. These EduKits have been shown to a small group of junior high school students and received positive responses, so it is expected to provide positive results as well.

5. Conclusion

EduKits 4.0 for learning solar energy conversion have developed successfully. In addition, learning process with this EduKits can make a positive gain from the junior high school students. For now, just a small group who tried it. For the future research will be applied to students with a larger scale, in order to meet the initial objectives of the study.

Acknowledgement

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