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Learning Smart through REKBEN Tube for Basic Electric and Electronic Subjects

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Technology is one of the factors that influences innovation in supporting learning activities as well as having the potential to help deliver meaningful learning to students. Electrical and electronic subjects are important subjects in technical and vocational schools as well as in the daily school divisions. It is difficult to understand the concept of how electric current flows. For example, a verbalized description of a printed reference may not give a person a clear image of the exact theory or concept that is intended to be conveyed. The problem that contributes to limiting the minds of young people in engineering is the lack of media technology in terms of helping students to understand the concept of electricity and electronics. The lack of tool kits in education that provide the technical characteristics that can illustrate the conditions of electricity and electronics made this research work. Therefore, this research proposal is to design, move, develop, and test the effectiveness of Augmented Reality (AR) technology focusing on electrical and electronic subjects as a teaching aid as well as reference materials to technical and vocational students. The results of this research will make technology increasingly in

demand by researchers and educators. This will provide more attention to the emergence of technology to further integrate this matter so that teaching and learning will become more effective and helpful in the STEM field in the future.

Key words: *Augmented Reality, Education Tool kit, Electric and Electronic Subject.*

Introduction

Technological advancement is a concept that cannot be avoided because it is in line with the advancement of knowledge. Humans have benefited from today's technology. Various technologies have been developed, including in the education sector. The use of technology in education is inevitable because students spend a lot of time outdoors by using technology, so it is desirable to expect them to recognize the advanced educational technologies that are capable of helping them in the learning process. Additionally, there is evidence of the effectiveness of technology utilization in some studies (Ghaleb Alnahdi, 2014).

Technical Education and Vocational Education (TVET) is the formation of human labour to meet the industry's workplace demand. It is very important because the Ministry of Education of Malaysia (MOE) is actively implementing the transformation of TVET into a developed nation by 2020. The upgrading of vocational schools to vocational college and the restructuring of vocational subjects in secondary schools was also implemented.

The field of electrical engineering plays an important role in bringing Malaysia towards becoming an industrialized country as the electrical and electronics (E&E) sector is an important contributor to the national economy where in 2009 it contributed 6% of Malaysia's gross national income (GNI) of 522,000 jobs and 41% of Malaysia's total exports (Economic Transformation Plan, 2010). Countries across the world need a lot of talent in electrical and electronics as the demand of labour in this specific area is increasing. Due to the rapid development of the electrical and electronic industries, higher learning institutions need to play a role in providing knowledge, experience and skills to students to cope with the demand (Uk Raai, Alias Masek, Mohd Hasril, 2014).

Literature Review

The purpose of this AR application is to make it easier for people to understand what is difficult to convey. The tools developed in this work have had a double effect as they allow teachers to improve their guidance during laboratory sessions and offer interesting teaching

aids and motivational tools to students during the learning process (Jorge, Pena, Wanda, Maria, Carlos, 2015).

Electrical and Electronic Engineering Courses

Electrical and electronics engineering courses are considered as the basic courses in electrical and electronics in vocational engineering education. The concept of charge and power supply is a starting course, followed by the circuit elements and the principle of current. In addition, the course provides students with exposure to electricity and power. Disclosure in this course will focus on electronic analogue circuits, devices, magnetism, magnetic circuits and digital electronic bases. Emphasis on training needs and skills that meet the demands of the industry, especially in the electrical-based industry, should be given attention by all public or private training institutions offering these fields of study. This will produce a quality training curriculum to produce graduates who can meet the occupational standards in electric fields (Zaliza, Arasinah, Tee & Mohd Hasni, 2016).

Education Theory

The Experience Based Learning Model described by Kolb (1984), which states that the learning process that gives students the opportunity to build their own experiences or experiencing everything on their own (Juwairiah, Jamilah, Anis, & Jamal, 2018). One of the most important factors in remembering and understanding knowledge over a long period of time is to provide interesting and meaningful experiences and learning throughout the teaching and learning process. Students in electrical and electronic engineering who lean more towards the technical side also need cognitive theory, which is based on learning theory that focuses on information processing (Mohd Izwan, Sidek, Jamaludin & Wan Marzuki, 2016). Learning is a process of relating new information to concepts relevant to one's cognitive function so that the learning process not only memorizes concepts or facts but also attempts to link the concepts together to produce a stronger understanding,thus making the concept that has been learnt better to be understood and not easily to be forgotten (Isbadar Nursit, 2015; Quarshie, Djimatey & Abakah-Anaman 2018).

Issues in the Basics of Electric and Electronic Circuits

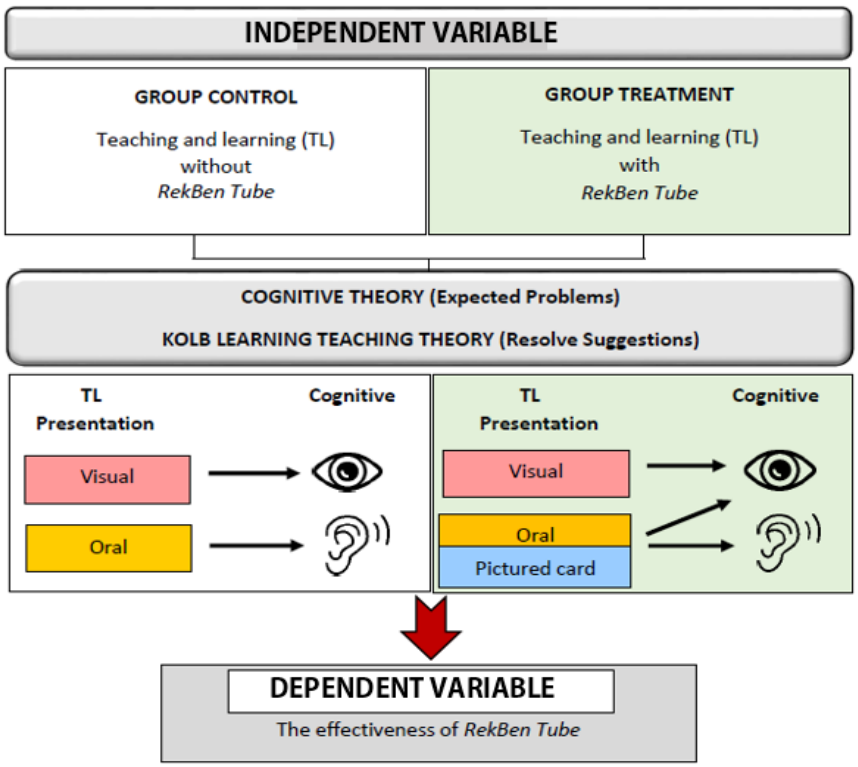
Learning electrical and electronic engineering based on spoken language and teacher-centred makes learning in the classroom less effective for students. Teachers can hardly describe the concept of a circuit with less imagination because the electric current is not visible to the naked eye, it must be visualized. Simulation techniques and learning can also be used to demonstrate the basics of electrical and electronic circuit theory. However,simulations take a long time to teach, depending only on the student activity, and

many students do not like simulated learning because of its complex learning and tight control (Afiful Brotherhood, 2017). In contrast to the technology of using AR to learning basic theory of the circuit because it is more convenient, more interactive, more effective and widely implemented into a variety of media- its production is also less costly and is easy to use, making many researchers interested in conducting this study. (Illumination & Nanang, 2017).

Research Framework

In order to produce a more effective learning process for students and to contribute high quality work to the country, the conceptual framework (Figure 1) below will explain how the information is delivered from the teacher to the student.

Figure 1. Conceptual Framework Model



The effectiveness of AR technology is important to see how far the level of achievement and understanding of students on the basis of electrical and electronic circuits. Technical learning requires a deep understanding, especially in its application when dealing with real objects. In addition, teaching also takes a long time to explain the actual concept to the

students, especially first year students of vocational schools who are still new to the technical subjects (Nor Zainiah Yahiya, 2006). There are two variables that can be classified as independent variables and non-dependent variables. The first group was a control group that did not use the AR application in classroom/workshops while the second group was a treatment group that used the AR application in teaching. The theory was developed to test the effectiveness of AR use in teaching and learning (TL). The processing of information in the human memory goes through two combinations of sensory, such as visual and verbal sensory. Not all students can learn something by using oral sensory, some students understand better and acquire information faster with the power of oral sensory and visual card. A personcan memorize longer by presenting through visual sensory, verbal sensory and picture cards.

Research Methodology

This study uses a fully quantitative (quasi-experimental) approach that involves only pre- and post-test. The study sample consisted of 30 vocational and experimental college students running for approximately 4 to 6 weeks. In this study, there were groups that were known as the control group and the treatment group. A t-test was conducted on both groups to see the effectiveness of the application. A questionnaire was also conducted on the respondents involved (electrical and electronic engineering students) to obtain more authentic data for this research.

Observation

Observation was conducted at a school, the Vocational College Sri Iskandar, and one class from that school was selected. The researchers chose one teacher to handle the class. The researchers stayed at the back of the classroom when the course of electrical and electronic studies was conducted to observe students' behaviour, acceptance of students towards the learning of the topic, and the method of teaching used by the teachers during learning and teaching. The researchers only sat behind the workshop throughout the observation process. Everything that happened in the classroom was video recorded and pictures were also taken. This observation was taken in the first week (pre-post) and the last week (post-test) of experiment. The researchers had also jotted down important notes in the notebook for future references.

Interviews

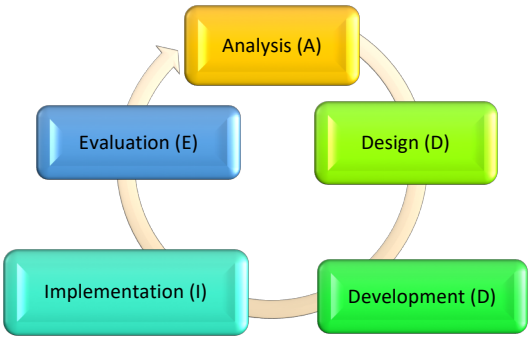
The research also conducted interviews with the teacher. This interview was conducted after the teacher ended their teaching session in class. The purpose of this interview is to measure

the level of understanding and achievement of students before and after *RekBen Tube* AR applications are applied to students regarding electrical current and electronic circuits.

Research Design

According to Nik Aziz (2003), the framework is the basis of the study which illustrates the approach used in this study. It can be considered as a reference to provide the context for research problems or questions that are the focus of the study. To build this AR application, the methodology used is the ADDIE model.

Figure 2. Framework by ADDIE process



This study uses the ADDIE study design voluntarily. The ADDIE model is a product-oriented model. The first process of this design is analysis. The process of analysis involves multiple processes to determine and identify problems to be resolved. The analysis stage functions to determine the needs of users whether they are needed or not in this era of technology.

The second process involves the design process. At this stage, an overview of the form, structure, theory, type of media and technology will be involved. This phase is crucial in determining the development of strategies to achieve teaching goals. The elements in the design phase include target, objective writing and test items, choosing a delivery system and how to prepare teaching.

The third stage involves the construction phase (development) to build a real system using all the media and technology elements selected based on the title requirements. The purpose of this phase is to produce an easy-to-use application and latest teaching technology. The development work for this multimedia project will be made by the agreed specifications. Every development will be tested and seen gradually, resulting in a fairly satisfactory production of users together with efficient and different use from other teaching aids.

The fourth process is the implementation stage. At this stage, teaching materials are used in real terms. The AR application will be used to test the effectiveness to identify errors or satisfaction and increasement of the app. In the event of an increase or repairing error made is prior to the submission of the actual target.

The last step is the evaluation phase. This phase is divided into two types, namely formative and summative evaluations. Formative assessment is an assessment conducted at all levels to ensure its effectiveness. Summative assessment involves testing content elements, strategies and multimedia elements by interviews, questionnaires, supervision and testing. This product rating is not a formative assessment that involves formal interviews, but rather provides questionnaires to target users once the AR application is shown.

Test

In this design, the respondents are divided into two groups namely control group and treatment group as Table 1 shown below. Both groups have gone through the pre- and post-test. Based on the Table 1 below, both groups have taken the pre-test (T1) at the beginning of the study, prior to the implementation of the intervention to identify the students' existing skill level. Subsequently, the researcher performed the treatment (X1) which was the implementation of first activity for approximately four weeks against the children in the control group. Meanwhile, the children in the control group received normal learning during that time. Subsequently, children in both groups took the post-test (T2) to determine if there are any changes to their existing skill level.

Table 1: Pre-Post Tests Design

Group	**Number**	**Pre-Test**	**Treatment**	**Post-Test**
Control	15	T1	-	T2
Treatment	15	T1	X1	T2

Guidance:
T1- Pre-Test
X1- Treatment
T2- Post-Test

All data collected was analysed using Statistical Package for Social Science (SPSS) version 18.0 software as it was more efficient and faster for statistical analysis work. There was two type of process analysing data which is the descriptive statistics and the inference statistics. To answer the research question, inference statistics were used to derive results from the pre and post-tests while descriptive statistics were used on the distributed questionnaires.

Questionnaire

The tool used for electrical and electronic engineering studies was the AR application. In addition, the questionnaire was also given to each individual respondent (student) to get feedback on the AR application to be shown. The questionnaire was prepared and required the respondents to complete the form after the AR application was conducted. The questionnaire is divided into three sections which is for Part A: Background, Part B: Responses with respect to AR, and Part C: Suggestions and improvements.

Result

The testing of the AR application, *RekBen* Tube has been tested on 30 respondents in a school to see how effective it is. This test also aimed to ensure that this application has functionality and effectiveness as well as find faults in the application. The application test comprises the testing process of installing this application into a mobile phone in the .apk file and then testing it to technical and vocational students in electrical and electronics engineering.

Experimental Design

30 students participated in this experimental test. The age of all the students are the same and they are also all electrical and electronic engineering students. No student has prior knowledge on the topics to be tested and evaluated, or have any experience on using the Augmented Reality app (AR). The experimental tests performed on students consist of four main steps:

1. Pre-test (T1): The first step of the experimental test is to do a pre-test to know the prior knowledge of the students in assessing electrical and electronic subjects before using the *RekBen Tube* (AR) application. This pre-test consists of 10 questions on electrical and electronic basic and electrical current on systematic circuit for Technical and Vocational students. This test was given to both groups.2. Interaction with teacher is only allowed for the Control Group: Teachers teach as usual in the classroom without the use of teaching materials other than the existing textbooks. The two-way interaction occurs between the teacher and students only. Interaction with the *RekBen Tube* (AR) application for the Treatment Group (X1): The teacher acts as an assistant to the students as they describe the oral theory on the basis of electrical and electronic circuits. The students then take a card with electronic circuits as a teaching aid. Students are formed into two groups to facilitate teachers to explain what they have learnt. The hardware used to drive the app is the OPPO

F9 smartphone. Students have a maximum of 10 minutes to interact with the application along with given circuit cards.

3. Post-test (T2): The third step is to create a post-test to determine the level of understanding and efficacy of the student on the application. Like the pre-test, the post-test also contains 10 questions to investigate whether the application helps them to understand the basic concepts of electronic circuits or not. Subsequently, students were given a questionnaire to answer the relevance of the tooling of the Augmented Reality (AR) technology application kit.

4. Investigations: Finally, the experimental test can be concluded after students make a survey based on the Likert questionnaires on learning and interaction processes with this AR application.

Results and discussion

Results obtained from the experimental tests performed by students in the level of learning achieved by the students. The tables 2 below show the mastery level by student according to their score.

Table 2: Mastery Level

Scores	**Levels**	**Description**
0 to 3	Very weak	Students master very little knowledge and do not remember the lessons taught.
4 to 7	Weak	Students have the knowledge but do not remember the lessons learned.
8 to 11	Average	Students are making progress in their knowledge and trying to remember the lessons learned.
12 to 15	Good	Students have mastered a great deal of knowledge and can remember learning.
16 to 20	Very Good	Students have a lot of knowledge and can remember the lessons learned very well.

Table 3 shows the pre-test and post-test scores on the mastery of basic learning electrical and electronic to technical and vocational students. Students in the control group experienced only a 1.00 increase in learning levels from 10.40 (T1) and 11.40 (T2). That means the level of student control of the control group is moderate. Descriptive analysis found that the average improvement in the treatment group score of 4.93 was higher than the control group score of 1.00. The independent samples test was used to confirm whether there was any learning effectiveness before using the *RekBen Tube* app and after using the application to control and treatment group.

Table 3: Pre-Test Score and Post-Level Test Score of RekBen Tube Application Effectiveness

Respondents	Control Group			Treatment Group		
	Test Score		Improvements	Test Score		Improvements
	Pre	Post		Pre	Post	
1	10	11	1	9	13	4
2	13	13	0	10	15	5
3	12	12	0	8	14	6
4	9	10	1	10	12	2
5	13	12	-1	8	13	7
6	8	9	1	8	15	7
7	10	12	3	7	10	3
8	13	13	0	10	16	6
9	12	15	3	9	15	6
10	11	13	2	12	17	5
11	11	11	0	10	16	6
12	9	9	0	11	16	5
13	9	9	0	13	17	4
14	8	12	4	13	18	5
15	8	10	2	12	15	3
Average	10.40	11.40	1.00	10.00	14.80	4.93

The second result is a Likert questionnaire about the learning and interaction process with this Augmented Reality (AR) application. The results can be seen in Table 2 below.

Table 4: Survey statement and responses from the student

*Likert Scale: 1= Strongly disagree, 2= Disagree, 3= No opinion, 4= Agree, 5= Strongly agree						
No	**Statement**	**1**	**2**	**3**	**4**	**5**
1	"It was easy to interact with the augmented reality application"	0	0	2	13	15
2	"It was clear and easy to understand the description with the augmented reality application"	0	0	2	10	18
3	"Presentation of augmented reality content helps me understand the lesson more effectively"	0	0	2	12	16
4	"It was easier to understand the concepts using an animation than a static 3D model"	0	0	1	14	15
5	"This app encourages users to get it"	0	0	3	12	15

From the results reported in this section, it can be summarized below about experiments performed to determine whether there is a difference in learning effect on the student before using the application and after using the *RekBen Tube* application (AR).

Table 4 shows the results of a questionnaire given to the students regarding the *RekBen Tube* (AR) application. Students agree that this app is easy to use and is interactable for their learning in the classroom when the teacher's description is provided. A total of 16 of the 30

students agree that they learn more effectively when using this app. Finally, referring to Table 2, the most important thing to be highlighted is that the *RekBen Tube* application has overall helped the electrical and electronic engineering students to better understand the basic electrical and electronic circuits than just using oral or traditional learning in-class.

Conclusion

The Augmented Reality (AR) application will provide an overview of the electrical and electronic circuits for technical and vocational students as this field is inadequate for teaching and learning material during the workshop to make it more effective. The AR will produce examples of the currents in circuits such as alternating current (AC), direct currents (AT), electrical circuit connections on components or devices and the creation of electrical circuit designs and others. The new students need an accurate understanding, especially to the theory of electrical and electronic learning as it is difficult to imagine regarding its current. Students should not be able to describe the picture of electric and electronic current travel generated in daily life. In order to provide a more engaging picture and learning technology, the Augmented Reality app is expected to help students actively learn, to better understand learning and to remember the concept of electricity and electronics.

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