



RESISTOR VALUE CHECKER KIT FOR EDUCATIONAL PURPOSE

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ABSTRACT

The use of technology in creating Teaching Aids (TA) for the Teaching and Learning (TL) process has a great impact on delivering knowledge and skills as well as expediting the learning process amongst students. Additionally, game-based TA plays an important role in improving the achievement and efficiency of students in the classroom. This research was conducted to develop the education kit for TL Resistor Color Code (RCC). The main purpose of this education kit development is to help students understand the RCC through a fun learning environment based on hands-on learning activity. This education kit known as Resistor Value Checker (RVC) kit is built on the concept of 21st Century Learning (21-CL) which concerns about the use of appropriate technology in the process of the TL in the classroom. It is designed with the latest facilities and different from existing products in the market.

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Keywords: teaching aids, teaching and learning, resistor, resistance

INTRODUCTION

Heeding the country's desire to become a developed nation by 2020, the teacher, as an agent of change, must play a key role in the process of Teaching and Learning (TL). In realizing their role, teachers should carry out their responsibilities to educate the students to ensure that they master the material well. Generally, the use of Teaching Aids (TA) in the process of TL especially in schools and colleges can help technical teachers to explain things and concepts of learning content more accurate than verbal explanations (Azman & Mustapha, 2014; Hanif et al., 2016; Tamuri et al., 2012; Tamuri & Yusoff, 2010). Ot-

herwise, the use of TA in accordance with the cognitive level of students can facilitate students self-learning based on their learning needs. The use of model or kit as TA in the TL process is one of the approaches practiced by technical teachers. In addition, educators can also provide an orderly, appropriate and effective teaching method to enable students in comprehending the material and achieving the objectives set out after completing the learning session (Biggs, 2011; Chalmers & Fuller, 2012; Khalil & Khairulanwar, 2011).

TA can be defined as the equipment used by teachers to assist them in delivering material related to some topics in the subject. It should be seen, heard, held, read, narrated, felt, inhaled, used, and so on. It even needs to be relevant to the learning topics taught. According to Altbac-

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het al. (2014) and Gay (2010), students have the potential to dominate knowledge, appreciate, and demonstrate positive social attitudes if TA is used during TL.

The use of TA in TL is to provide stimulus and attract students to follow learning so that they can understand and enjoy the process. Therefore, TA is important to be implemented for effective TL processes in determining the success of the learning program as well as stimulating the students' motivation and desire to learn (Nor & Sharif, 2014). The suitable and easy use of TA can help teachers in delivering the material through fun, exciting and interesting methods. Coinciding with the study conducted by Freeman et al. (2014), Hwang & Chang (2011), and Ja'apar (2017), the use of TA is important in the process of TL to engage and improve students' academic performance.

Studies show that TA is used to reduce boredom and increase students' interest in learning, as stated in the study of Harun et al. (2015) and Jamian (2016). According to Sumarni et al. (2016), students' understanding concept and psychomotor skills improve through teaching props production. According to Yusoff (2014), the use of TA in TL process can help students sharpen their senses so that they are able to achieve the effective learning. Based on the study conducted by Darusaram & Johari (2013), 53% of the participants stated that the use of the model they created make them understand, the next 15.4% of the them were interested and attracted with the model while 23.1% of them indicated that the use of the model makes learning easier and 7.7% of teachers give the perception that no other teacher is using such a model in TL. In addition, the convenient and needs of TA is sometimes inadequate or inappropriate used at schools. The use of appropriate TA in a teaching topic can stimulate and increase the student's desire to learn and know more about the topic. Whereas, TA is suitable for students who have a low and medium level of understanding. This is because an abstract conceptual teaching topic is difficult to explain and only students with a high level of understanding and imagination who can follow that teaching lesson. The appropriate and interesting TA can develop students' brilliant idea and encourage them to create more creative learning environment with the implementation of various activities in the classroom (Majid et al., 2012; Nordin & Ngau, 2009). In addition, according to Mathew & Alidmat (2013), TA is important in TL process.

Generally, Integrated Living Skills (ILS) subjects have been replaced with Design and Technology (DT) subject containing Electrical and Electronic topics. Students are exposed to basic electrical and electronic sub-topics such as the introduction of electrical components, voltages, currents, multimeters and so on. One of the electronic components often used in the workshop/laboratory for electronic projects is the resistor. Thus, students need to be able to determine the value of the resistor based on the color stripe on the body of the resistor. Traditional methods for determining resistor values are still used at schools by referring the Resistor Color Code (RCC) table.

Resistors are the basic components commonly used on an electric circuit. The study conducted by Hassan (2017) stated that each color has its own code that makes some students feel difficulty in memorizing and determining the exact values of the resistors. In this situation, students need to imagine and memorize the RCC to determine the exact values of the resistors. According to Shahrin (2015), it is difficult to explain the concept that requires students to imagine the teaching topics taught. Mahizan et al. (2017) also stated that students can not apply what they learn in practical work.

According to Aziz et al. (2017), the dropout of students in learning dominated is due to several factors such as inappropriate teaching materials, poorly organized learning content organizations, poor classroom environment and less diversity in teaching methods practiced by teachers. Furthermore, inappropriate learning techniques and methods affect students' academic achievement. According to Brahim et al. (2010), the two most preferred methods of teachers in Malaysia are lecture-based teaching methods and teacher-centered teaching methods in which students are not actively involved. This method encourages memorization rather than in-depth understanding. Therefore, this conventional approach does not expose students to soft skills, while it is a necessity for students in order to produce human capital that can meet the challenges of the real world. Therefore, if an attractive and innovative TA is not used in the TL session at school, the slow learners will be left behind and did not manage in dominating the topic.

Therefore, this study is conducted to design a product that can be used as a TA which is suitable for students at school even at the Vocational College (VC) and at Institution of Higher Learning (IHL) to facilitate them to understand

and dominate the skills of determining RCC with ease. This TA is named as Resistor Value Checker (RVC) kit. The RVC kit is a product especially designed as TA that can help and facilitate educators especially teachers in teaching about the topic of resistor in the electronic chapter as contained in the syllabus of ILS and DT subjects. The RVC kit is categorized as TA since it has the appropriate features used in TL. Using this RVC kit, students will better understand and remember the colors and know the resistance of the resistor by reading the color code on the body of the resistor easily and quickly. In addition, teachers are easy to handle, store and carry it anywhere.

The idea of designing and innovating TA is in the form of teaching kit in which RVC kit is a result of improvements from the construction and use of existing TA and commonly used by educators especially teachers at schools. It is also a highlight of the study conducted by Jantan (2010) which stated that researchers have developed a single TA color card and a magic box. The purpose of the researcher is to improve the students' skills in reading the color strip code of the resistor in the Integrated Living Skills (ILS) subject. However, the findings also show that the methods used still cannot improve the students' skills. The results show that only 52.8% of students can read the value of the resistor well.

Among other studies that serve as a reference in producing the RVC kit, there is a study conducted by the final year student of Sultan Salahuddin Abdul Aziz Shah (PSA) Polytechnic. In the study, researchers have been innovating TA called Resistor Educational Kit with Component Tester. The tools developed are more focused on lecturers and students in higher education. It aims to simplify the TL process in Electrical and Electronic Engineering. In this study, researchers have used Constructivism Theory in the construction of their TA. In addition, the built-in teaching kits can only be used in electronic or automechanical programs. However, these teaching kits are quite unattractive and not suitable at school level.

In addition, other related studies were the 4M Color Code Method for 4 Band Resistor model which was used as TA by Zakaria (2016). The researcher has developed a TA teaching kit to help students in practicing theoretical strength before they build electronic circuit projects for Resistor topics in Integrated Living Skills (ILS) subjects. The findings show that the objectives set by the researchers are achieved with 93.9% students can read the strip of the resistor line clearly. Furthermore TA known as Resistor Educational Kit is developed by Hassan (2017). The study found

that the TL process was more fun and the learning session would be easier with the help of this TA. Therefore, the RVC kit is developed using an Arduino platform which is different from TA as mentioned before. In a nutshell, an Arduino is an open hardware development board that can be used to design and build devices that interact with the real world.

Based on the results of the previous study, the use of TA in the process of TL especially at schools and colleges can help technical teachers to explain things and concepts of learning content more accurately than verbal explanations. Furthermore, the use of TA in TL is to provide stimulus and attract students to follow learning process so that they can understand and not feel fun. In addition, the suitable and easy use of TA can help teachers to delivery knowledge through fun, exciting and interesting methods. Moreover, the use of TA is important to engage students and improve students' academic performance. Besides, the use of TA in TL process can help students sharpen their senses to help them achieve effective learning. As well, appropriate and interesting TA can develop brilliant idea also encouraged students to create more creative learning environment with the implementation of various activities in the classroom. Students also have the potential to dominate knowledge, appreciate and demonstrate positive social attitudes.

Therefore, the RVC kit is designed and developed as the innovative teaching kit incorporating technology aimed at improving the existing TA deficiency to assist teachers and students in the TL process. The kit is also built based on the 21st Century Learning (21-CL) which emphasizes the use of technology that is in line with the TL process in the classroom. The scope of development of this teaching kit is in line with all levels especially at the secondary and Vocational College (VC) as well as Institutions of Higher Learning (IHL)

METHODS

The development of the RVC kit prioritizes two important features that are user-friendly and easy to maintain. During the teaching kit development process, some electronic components that are easy to use and do not harm consumers especially school students are considered. Among the electronic components used to produce these teaching kits are several types of resistors, push button ON / OFF, ON / OFF indicator lamps, arduino, positive and negative probe, power supply source and LCD display. In general, object ori-

ented methodology is used in the development process of a product. Object-oriented methodology consists of ADDIE Model, Waterfall Model, Prototyping Model, Evaluation Prototyping Model, Spiral Model, Extreme Programming Model and many more. The ADDIE model is used in this study because the phases involved are suitable for the RVC kit development (Desrosier, 2011).

Resistor Color Code Concept

Color plays a vitally important role in the world. Color can be a form of communication. Color can sway thinking, change actions and causes reactions. In Resistor topic, color is used to identify the colors of resistor color coding accordingly. RCC is a system of colors used to indicate the resistance value of resistors that uses colored stripes or bands printed on its body. The value of resistance can be calculated based on the RCC. Figure 1 shows resistor with four bands printed on its body. Figure 2 depicts RCC to indicate the resistance value of resistors.

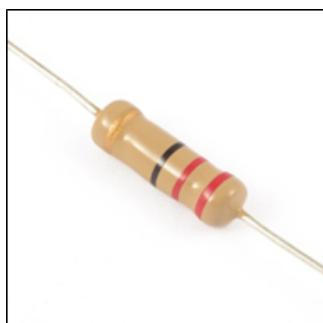


Figure 1. Resistor

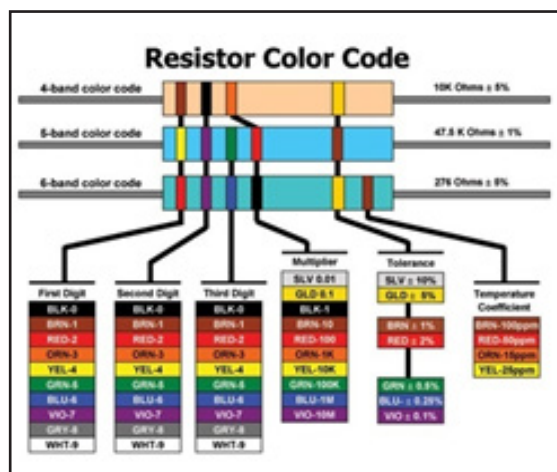


Figure 2. Resistor Color Code

Product Design

In order to realize the development of this teaching kit, ADDIE model was selected.

ADDIE model is one of the design instruction models that often become the basis for other instruction design models. Generally, the ADDIE model consists of Analysis, Design, Development, Implementation and Evaluation phases (Jones, 2014; McGriff, 2000). The ADDIE model is a basic instruction design that can be integrated into any learning strategy. According to Richey & Klein (2014), the ADDIE model is a generic model, has a systematic approach to the process of designing instructions and providing designers with an orderly framework to ensure that the educational products produced are effective and creative processes are extremely efficient.

Analysis

Prior to developing a product, the analysis of the product is appropriate. The analysis process covers the problems faced; product requirements include the objective of developing the product. Before the product was developed, the research is conducted to identify the problem faced by the teacher in delivering the contents of the lesson as well as the students in the knowledge and understanding of the resistor topics in the subjects of Integrated Living Skill (ILS) and electrical and electronics. This initial study is very important in determining the objective of developing the RVC kit. The findings for the analysis process is further discussed in Section Results and Discussion.

Design

After analyzing product requirements, researcher then designed the product. The product designed included TA initial sketches. Among the features emphasized in designing the home design kit were ergonomics, security, materials and cost. Figure 3 illustrates RVC kit design.

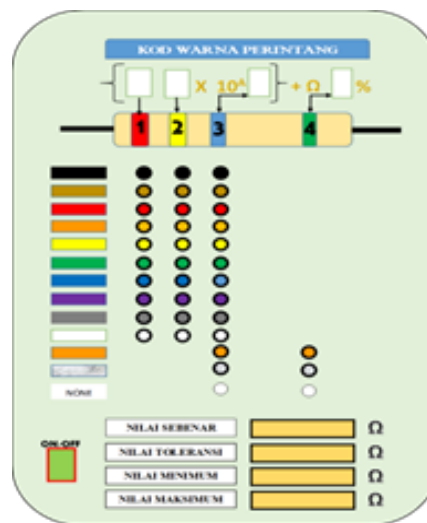


Figure 3. RVC kit design

Development

After the design phase, the development phase was done. The product was developed based on the prototype design. Product development involved the development of the desired programming and installation of components to be used. Figure 4 and Figure 5 show the RVC kit.



Figure 4. Resistor Value Checker (RVC) Kit



Figure 5. Resistor Value Checker (RVC) Kit

Implementation

After the product was developed, the implementation phase was carried out. Testing conducted in the form of pilot test on several samples consisted of students, teachers and lecturers who had been selected. Product demonstrations were also performed in front of the sample as depicted in Figure 6.



Figure 6. Teaching Aids Demonstration

Evaluation

The findings for the need and interview analysis was further discussed in Section Results and Discussion.

RESULTS AND DISCUSSION

The RVC kit is a specially designed and innovated lesson kit for TL sessions for Resistance topics in ILS and DT subjects. It is designed to facilitate teachers and lecturers who teach resistor topic as well as to enhance student understanding to apply theoretical learning in practical class easily and quickly. The strength of this teaching kit is to facilitate the teacher and help students improve the skills of determining the value of the resistors. Student can explore the RVC kit and learn RCC topic by self-learning without teachers guide. The RVC kit is evaluated by experts in the field of Electrical and Electronic for the purpose of product validity using interview methods. Seven lecturers from several Vocational Colleges (VC) were interviewed to get their feedback on RVC kit effectiveness to ease TL process for resistor topic. Respondents were selected based on the criteria of teachers who are experts in the field of electrical and electronics and have served more than five years as a lecturer.

Phase 1: Need Analysis

This requirement analysis study used interview methods for seven lecturers from several Vocational Colleges (VC) to identify the problems their students face to dominate resistor topic and get their feedback on TA development to ease TL process for resistor topic. Respondents were selected based on the criteria of teachers who are experts in the field of electrical and electronics

and have served more than five years as a lecturer. Based on the interview analysis, the findings from the seven respondents were as follows:

Theme 1: Your students can accurately memorize the color code of the resistor

A total of seven respondents disagreed that students could memorize RCC accurately. Respondents 5 (R5) and Respondents 7 (R7) stated that their students were difficult to memorize the color code of the resistor exactly as the students lacked focus in the classroom. Respondents 1 (R1), Respondents 2 (R2) and Respondent 3 (R3) stated that their students lack the ability to read the RCC manually because there are more than ten colors to remember. Respondents 4 (R4) felt that students were difficult to memorize RCC accurately because they did not find a concept that is easy to memorize the RCC appropriately.

Theme 2: Your students can finish the task of accurately counting the color code of the resistor

A total of five respondents indicated that some of the students were completing the exact color correction code because the students used the RCC application that was downloaded in their phone while two respondents think that the student's error in calculating the value of the resistor is due to the negligence of the student reading the RCC in the given table.

Theme 3: The majority of your students can answer questions accurately in calculating the RCC in the test or final exam

When asked about student achievement in the test or final exam, the majority of seven respondents think that some of their students can answer questions accurately calculating the color code of the resistor. Some students can not answer exactly because they do not memorize the RCC properly.

Theme 4: Lecturer needs appropriate TA to stimulate TL

The majority of the seven respondents stated that the appropriate TA needed to encourage active involvement of students in the TL process. They suggest learning kits related to color coding resistors using self-learning approaches. This self-learning learning concept kit can help them practice their own exercises. Among the suggestions raised in terms of kit designs and other details that would be developed to achieve the objective of learning outcome of the RCC.

Theme 5: Teaching activities should consider the ability of students to learn

Four respondents agreed that teaching activity should be based on the ability of students to learn. According to respondents, most students have different backgrounds. So, the easy-to-understand and appropriate teaching methods of students' ability should be taken into account when conducting TL. A total of three respondents said that some students have very limited ability to think because they are not ready to learn. Lecturers need to plan teaching methods that suit students' ability to achieve learning outcomes.

The results of the need analysis found that appropriate teaching kits should be developed to help lecturers conduct TL better. The findings show that most lecturers agree with the importance and benefits of this teaching kit to students. In short, the developed teaching kits should take into account suggestions and specifications such as appropriate design, easy to carry and user manuals to explain how to use it.

The RVC kit is developed to facilitate the TL process. It is designed specifically to facilitate students, teachers and lecturers in recognizing and knowing the value of resistors. The use of existing RCC table and analog multimeter makes it difficult for students to determine the value of the resistor. The small size of the resistor body makes it difficult for the student to determine the actual color on the body of the resistor because the band color on the corresponding resistor body causes the wrong reading of the resistor value. The use of analog and digital multimeter does not help the student to determine the resistance value because some students do not understand the right way to use the multimeter and unaware the right way to read resistor value especially when using analog multimeter even though it has been explained.

Phase 2: Interview Analysis

Based on the interview analysis, the findings from the seven respondents were as follows:

Theme 1: RVC Kit Design

A total of five respondents stated that the size of the RVC kit is quite large. Respondents suggested that smaller RVC kit sizes should be developed so the kit is easy to carry. However, when the demonstration of the use of the kit is shown, the majority of respondents agree that the

kit is easy to operate as there is a user manual as a reference. All seven respondents stated that this kit is user-friendly because there is no part or component on the kit that could endanger or injure the user. When asked about the push button switch on the kit interface, four respondents stated that the push button switch position is in the appropriate position. Three other respondents stated that the position of the push button switch on the kit interface illustrates the actual RCC table.

Theme 2: User manual design

All seven respondents felt that the user manual is easy to understand because it uses a combination of appropriate text and graphic images. In addition, various examples of questions were provided so users can practice on their own. Indirectly, this RVC kit encouraged self-learning among students. In addition, the use of this kit was also described in detail to the user manually.

Theme 3: RVC kit effectiveness

The majority of the seven respondents felt that the RVC kit produced illustrates how to read the RCC clearly with an attractive approach. The use of this kit is also suitable in TL regarding the topic of resistance and helps teachers deliver TL easily. In addition, this kit is suitable as a personal tutor for students.

CONCLUSION

Teaching kit is one of the innovative methods of TA at schools. TA is used by teachers to make TL process is easier to understand. As such, the RVC kit is developed in accordance with the psychological aspects of the child and according to their capabilities and ability with different skills. This teaching kit is built to facilitate students to learn, understand and indirectly dominate the way of reading and calculating resistance values practically through learning taught in theory. In addition, this teaching kit can also be used by students at Vocational College (VC) as it is easy to operate, sophisticated and technologically and suitable to use at all education levels according to current circulation. In addition, it also facilitates students to understand and apply the theoretical learning that has been learned in practical class.

The findings showed that the production of TA known as RVC kit is required to fulfill the TL objectives for the topic of the resistor. In addition, this teaching kit is based on plug and play approach which is more fun and self-learning to

build knowledge and understanding about a concept involving student interaction with TA. The development of this RVC kit can help ease the TL process for resistor topic.

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