International Journal of Engineering Trends and Technology
ISSN: 2231 – 5381 /doi:10.14445/22315381/IJETT-V69I1P215
Volume 69 Issue 1, 97-103, January 2021
© 2021 Seventh Sense Research Group®

Electronic Educational Quiz Board for Block Diagram Learning in Control Principle Subject through Android Application

Zakiah Mohd Yusoff [1], Nur Intan Zulaikha Hanafiah[2], A. F. Z. Abidin, Kamaru Adzha Kadiran[1], Mohamad Haniff Harun[2], Rozi Rifin[1], Khairul Kamarudin Hasan[1], Ahmad Fariz Hasan[3]

[1]*Fakulti Kejuruteraan Elektrik, Universiti Teknologi MARA, Cawangan Johor, Kampus Pasir Gudang, Jalan Purnama, Bandar Seri Alam, 81750, Masai, Johor Bahru, Malaysia*

[2]*Fakulti Teknologi Kejuruteraan Elektrik & Elektronik, Universiti Teknikal Malaysia Melaka, 76100 Durian Tunggal, Melaka, Malaysia*

[3]*Faculty of Engineering Technology,Universiti Malaysia Perlis, Kampus Alam UniMAP, Pauh Putra, 02600 Arau, Perlis, Malaysia*

[1]zakiah9018@uitm.edu.my

Abstract *— Understanding the block diagram concept to learn the control system topics such as open-loop or close-loop for the feedback system is crucial to developing student knowledge for the real world. An Android Application to introduce a method to learn the block diagram concept with an electronic quiz board using a microcontroller has been proposed in this project. To bridge the gap between the subject's theoretical and practical elements, a hardware quiz board is also being introduced along with the Android apps. This prototype is called Block Diagram Intelligent Learner (I-Learner), which will display the question in terms of scenario on the dedicated Android application. The student needs to connect the corresponding control blocks on the quiz board to answer the question. The Android application will provide feedback to the student with the correct solution. The validation on this educational kit covers scenario testing to determine the functionality of the kit, the reliability testing, and the survey to determine the effectiveness of these educational kits. The result shows that the proposed educational kit had fulfilled all the proposed objectives.*

Keywords — *Educational Kit, Electronics Quiz Board, Android Application, Control Principle, Block Diagram*

I. INTRODUCTION

Engineering subjects normally will have theoretical and practical aspects for the learning process to adhere to engineering body accreditation. One of the Electrical Engineering Syllabus subjects includes the Control System subject that is usually taught by attending theoretical classes and practical laboratory sessions. For theoretical class, students usually are exposed to fourteen sessions of two hours face to face class lectures and three sessions of tutorials consisting of two hours per session. Meanwhile, for the laboratory session, students must go for six lab sessions consist of three hours per session. Many contact hours are required in this subject to ensure students can grasp the engineering concept in the Control System subject. The demanding number of hours for contact lecturers' session has caused some of the topics covered hurriedly by the lecturer in theory. Hence this project is proposed to enhanced student learning capability for one of the subtopics in the Control System subject without lecturer supervision and at the same time to increase students' interest in the subject.

Android application has been widely used to enhance teaching and learning purposes or to enhance daily routine job. Zheng, W. et. al.[1] has developed Android Apps for energy monitoring in Smart Campus. The campus's energy monitoring has been made in real-time, clear, and efficient that integrated with database and android apps. On the other hand, Feng L. et al. [2] have developed a remote wireless meter reading system bade on 3G technology using Android App development. The project includes database development, a software terminal with mobile apps, and integrated with remote wireless automatic meter reading devices. Sayono, J. [3] has used android apps to enhanced the learning experience for history learning about the Projo Bale model in Malang. The use of the apps for learning has found that the model is as viable and as effective as an innovative model in the study of history. There are several educational kits has been developed for learning purpose that combined with hardware using microcontroller to enhance the student learning experience or to ensure subject learned is easily understood by the students

Mustapa R.F et al. [4] have proposed an Embedded CDIO element in the final year project to attract students' interest for fun learning in the engineering subject. In this project, the conventional mastermind board game has been developed by using the Arduino Mega controller. The project has shown that students could develop critical thinking and improve psychomotor skills by implementing educational kits in their learning process. Faseh, M. H. A. H. A. M. et al. [5] have worked on educational kits for E-PLC to translate mnemonic codes into hardware simulation. The project used a low-cost Arduino Microcontroller to simulate PLC mnemonic codes on the hardware to learn the subject without much supervision from the lecturer. Anuar, A. et al. [6] have

This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

developed an electronic board that checks the common electronic components or modules being used on Arduino board called E-Tester. The prototype is built using Arduino Mega, several sensor modules such as LM35, ultrasonic, water sensor, LDR, as well as other supporting components such as LCD, 7 segments, buzzer, LED, joystick and keypad. The prototype is low cost and able to check twelve commonly used Arduino components for student usage in their project development.

The educational kits also can be used to aid the learning process for the Control Principle subject. Zakaria, M. F. Z. M. et al. [7] have proposed to use Arduino Mega Controller to develop second-order transient response by using DC motor speed controller to understand the learning topic in transient response for the subject. Most of the respondents on the survey have given positive feedback and could improve student knowledge in the Control Principle subject. Abidin, A. F. Z et al. [8] have produced the student's prototype to test C programming concepts using flowchart command. The flowchart is the part of the main concept needed to understand by students who learn programming language. Hence, understanding is crucial to develop their psychomotor. This prototype is developed using Arduino Mega 2560 controller. Zabidi, M. I. Z. M., et al. [9], on the other hand, has proposed E-Transform, an educational tool to understand mathematical transformation concepts by hands-on. The project is developed for high school students to assist their learning in mathematical transformation.

K. A. Kadiran et al. [10] also proposed an educational kit to learn control system topics in transient response using water level application. The kit will generate several questions once the transient response is plotted base on the water level system being operated. The prototype is developed using an Arduino Mega microcontroller.

Besides the education kit, the traditional games also could be developed using Arduino Microcontroller. A. F. Hafizan et al. [11] have developed E-Congkak, based on the Malaysian traditional game Congkak. The board game has developed using Arduino Mega, seven segments display, LED, button, and buzzer to imitate the real traditional Congkak game.

Asraf, M. H et al. [12] has developed teaching aids for Industrial Instrumentation subjects that use LabVIEW and IoT (Internet of Things) platform for computer-assisted E-Laboratory. The project used Arduino-Expresso8266 and LabVIEW software platform with Blynk software to remotely control PID setting for the equipment known as the LD-Didactic temperature system. Rozani, I. A. et al. [13], on the other hand, has developed the prototype base on the Othello Board Game that uses an electronic hardware version. The prototype is developed using Arduino Mega controller, 64 RG LED being used to imitate real gaming. Users will use the joystick to move the player. Karis, M. S. et al. [14] has proposed an educational kit that is Laplace Circuit Solver. The project is an educational board simulator to produce an electrical circuit Laplace Transform Equation developed using Arduino Mega. The prototype can translate a given electrical circuit via tactile insertion of the component through its domain frequency transfer function. Halim, M. F. A. et al. [15] have developed an educational kit with an Android application that tests student knowledge in Series and Parallel resistor theory for Electrical Circuit theory subject. Base on the survey, respondents agree that it can help students understanding and increase student interaction to learn theory subjects. Ab Halim, M. F. M. et al. [16] on the other hand has proposed Reseducational kit to help student learning in resistor concepts with quiz-style learning. The educational board is developed using Arduino Uno. Meanwhile, R. Rifin et al. [17] have developed an Android-based exam implementation called Examwiz to implement for the student examination.

Clearly, the literature review outcome shows no past kinds of literature had attempted to develop an electronic quiz board that test the student knowledge, specifically on Control's Block Diagram. Thus, the proposed project aims to develop an electronic quiz board that allows the student to test their knowledge on the topic by answering application questions displayed on a dedicated Android application

II. METHODOLOGY

The project can be divided into two categories that are hardware setup and software interface. The main components are microcontroller and electronic components such as Bluetooth module, wire jumper, resistors, and female pin headers for hardware setup. Bluetooth Module HC-05 is used as a communication medium between Arduino and mobile apps, while Arduino Mega microcontroller is used to process the input data from users and communication between Android apps and the hardware. A big number of jumpers are required to connect the block diagram, and several different values of resistors for the different types of solutions are also required. Fig. 1 shows the block diagram of the proposed project.

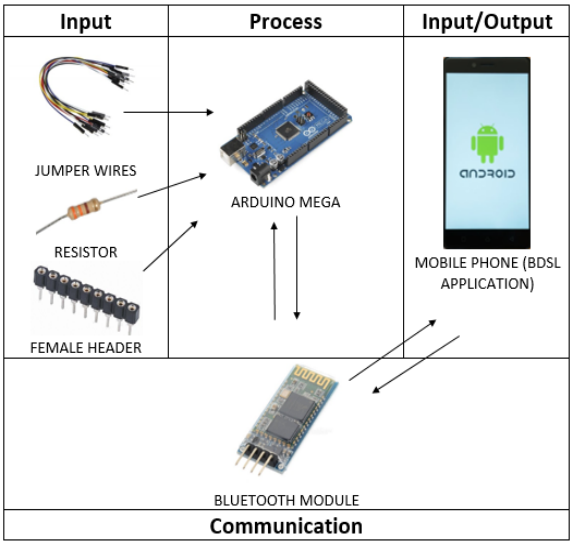


Fig. 1. Block diagram of the proposed prototype

Fig. 2 illustrates the casing's initial drawing for the proposed prototype that draws using Google Sketch, while the bottom image shows the actual building of the prototype casing. The container is made of plastic base material type. The circuitry connection between components, Arduino Board, and power supply is placed inside the box.

Fig. 3 shows the illustration of the schematic using Proteus 8 Professional Software. Each input header is connected in series with a fixed-value resistor with 330 Ω, except J1, J2, J3, J4, and J5. The connection of powers supply and ground for Bluetooth module is directly connected to Arduino Board pin of GND and 5V, while transmitter (Tx) and receiver (Rx) are connected alternating cross with Arduino pin 1(Tx) and Arduino pin 0 (Rx).

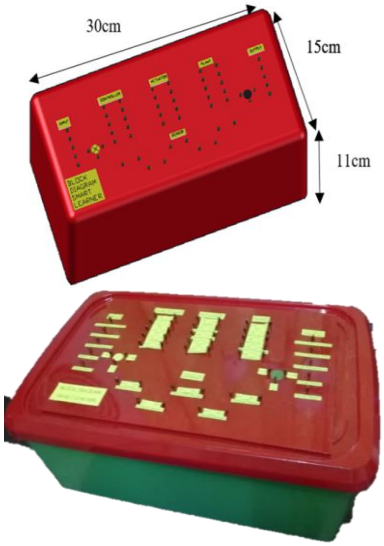


Fig. 2. The drawing of the proposed prototype (top); the Real image of the Block Diagram Intelligent Learner (bottom)

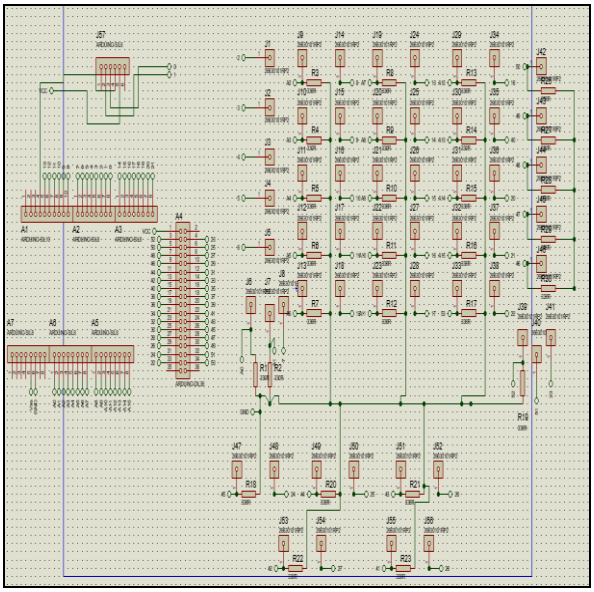


Fig. 3. The schematic design of the circuit

Fig. 4 describes the components used to build the prototype and were grouped into three categories. The top layer components were placed on the top of the prototype box. The top layer will be visible to the users, while the bottom layer will not visible as it inside the box. The components that were placed inside the box include resistors, Arduino Mega, and Bluetooth module. Female-to-male jumper wires were used to connect between the bottom layer and the top layer. At the same time, male-to-male jumper wires were used on the top layer to connect the blocks to answer the question displayed by the Android application. The remaining components under the miscellaneous category were used as the label or the educational kit's appearance.

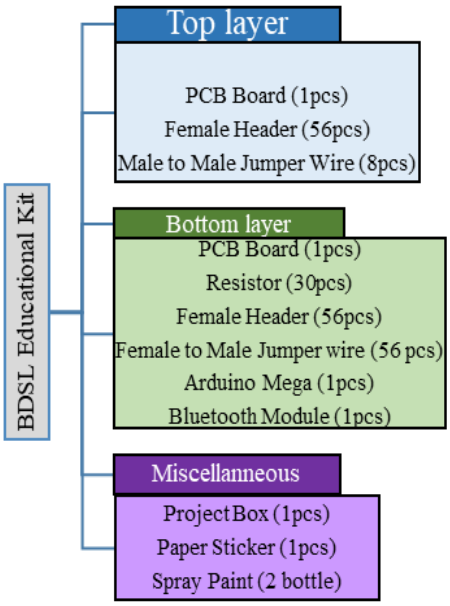


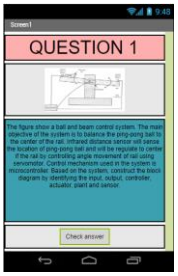
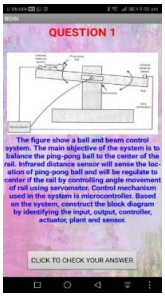
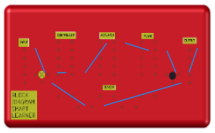
Fig. 4. Overall material of the prototype

III. RESULT AND DISCUSSION

The proposed educational kit has been tested using three methods: scenario testing to determine the kit's functionality, reliability testing to determine the physical endurance of the kit, and the qualitative survey to know the effectiveness of the kit. Table I showed an example of the scenario testing employed in this project. Users will answer the Android apps' question by constructing the block diagram connection using male-to-male jumper wires. Once the users complete making the connection, the system will check to know whether or not the answer is correct or wrong. If the answer is correct, the apps will alert users, and the correct block diagram will also appear.

Meanwhile, if the other way round, the apps will let users know that their answer is wrong. Figure 5 shows if the user's answer is wrong. Table 2 shows other questions that are stored inside Android apps.

TABLE I
SAMPLE OF THE QUESTION AND ANSWER FROM ANDROID APPS AND HARDWARE CONNECTION

Scenario	Expected Result	Actual Result
The Android application displayed Question 1, and the student must read the question and try to identify the related blocks that will be used. The picture is provided as an illustration of the question.		
The student starts to answer the question by making the connection between the blocks using male-to-male jumper wires.		
Android App will check the answer and display the result. If the answer is correct, it will display the correct block diagram connection and statement that stated the user answered the question correctly.		

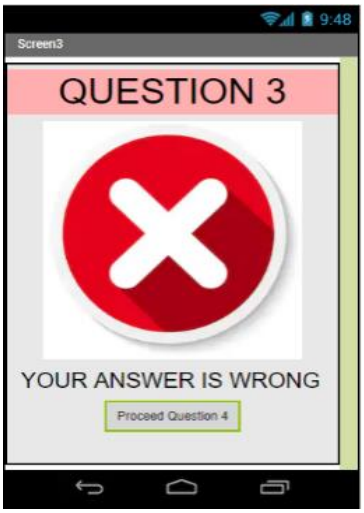
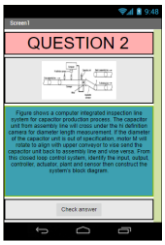
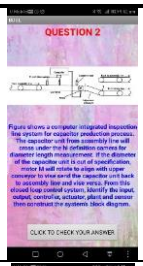
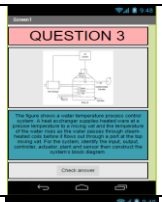
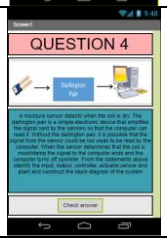


Fig. 5. The image when users answer is wrong

TABLE II
SAMPLE OF THE OTHER QUESTION FROM ANDROID APPS BDSL.

Scenario	Expected Result	Actual Result
The Android application displayed Question 2.		
The Android application displayed Question 3.		
The Android application displayed Question 4.		

The reliability test was performed by conducting two testing types: the drop test and the temperature test. Both tests were done to ensure the prototype can withstand the physical force applied to the prototype. The drop test was exercised to ensure that all components were installed firmly into the board to avoid loose components when the prototype accidentally falls from a certain height. The height of the drop test was done at two heights that were 0.5 meters and 1.0 meters. After the drop test, the kit will undergo a functionality test. The result is shown in Table 2. The result shows that the functionality of the kit is still working when falling at the mentioned height. There was only cable loose and box scratch when fall occurred at 1 meter.

TABLE III
RESULT OF DROP TEST ON THE PROTOTYPE

Height (m)	Frequency of drop test	Observation
0.5	1	Functionality intact.
	2	
	3	
1.0	1	Functionality intact, few cables loose.
	2	
	3	Functionality intact, few cables loose, project box scratch.

Temperature testing has been conducted on the prototype kit box to find its durability in two different temperature conditions. For hot conditions, the kit was exposed to a temperature above 30℃ (under the hot sun)

for three hours. The result was recorded in Table 3. Every hour, the kit was tested to know the kit's functionality, and the result shows it still functioning well after three hours of exposure under the sun. For cold conditions, the kit was placed in the fridge's cold storage, whereby the temperature is set to less than 3℃ for six hours. Table 3 shows the time and condition test of the kit. Hence, the result shows that the kit could withstand the temperature from hot (under the sun) to cold (inside the fridge) for several hours, and still, the kits' electronic components were working as expected.

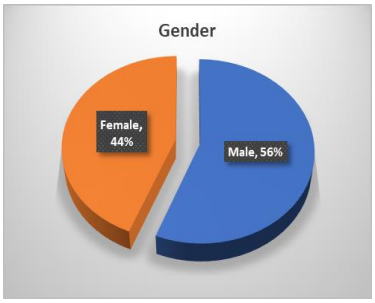
TABLE IV
RESULT OF TEMPERATURE TESTING

Product Test	Time	Result
Hot condition 	2.30 pm	The functionality of the kit intact.
	3.30 pm	
	4.30 pm	
	5.30 pm	
Cold condition 	11.00 am	The functionality of the kit intact.
	12.00 am	
	1.00 pm	
	2.00 pm	
	3.00 pm	
	4.00 pm	
	5.00 pm	

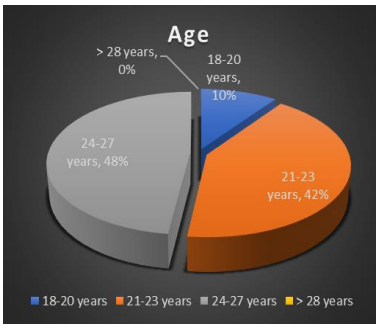
A survey had been conducted and distributed among students from the Faculty of Electrical & Electronics Engineering Technology and Faculty of Mechanical & Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka. Table 4 indicates the part of the questionnaires distributed to the respondents. There were around 50 respondents, consisting of 28 males and 22 females, as shown in Fig. 6. While Fig. 6 (right) shows the respondents' age whereby 24 out of 50 respondents were 24 – 27 years old, 21 were 21-23 years old, and five were 18-20 years old. Roughly, the survey was answered by students from FKTEE & FTKMP. The answer for every question is in the Likert Scale range, which means 1 as strongly disagree, 2 as disagree, 3 as neutral, 4 as agreed, and 5 as strongly agree.

TABLE V
LIST OF QUESTIONNAIRES

Q1	**Do you agree Control System is an interesting subject?**
Q2	**Is the Block Diagram Intelligent Learner educational kits related to the topics in Control system?**
Q3	**Is the Block Diagram Intelligent Learner educational kit difficult to use?**
Q4	**Do you agree that Block Diagram Smart Learner's educational kits help to improve learning effectiveness?**
Q5	**Is the usage of Block Diagram Intelligent Learner help to save students learning time?**
Q6	**Is the Diagram Smart Learner educational kit help improve students' learning to understand Control System's topics?**
Q7	**Do you agree Diagram Smart Learner educational kit provides students deep knowledge to understand topics in Control System?**
Q8	**Do you think that Block Diagram Smart Learner's educational kits play an important role in understanding Control System's topics?**



(a)



(b)

Fig. 6. Gender respondents (a); Age of the respondents (b)

Fig. 7 shows survey results on the questionnaires distributed to the respondents. The first question asked whether the Control Principle is an interesting subject, and five respondents state that the Control Principle is not an interesting subject. 15 respondents disagree, and 11 respondents have a neutral opinion about the subject. Only five respondents agree, and 14 strongly agree with it. This might be due to some sub-topic in the Control Principle, either easy or hard to learn.

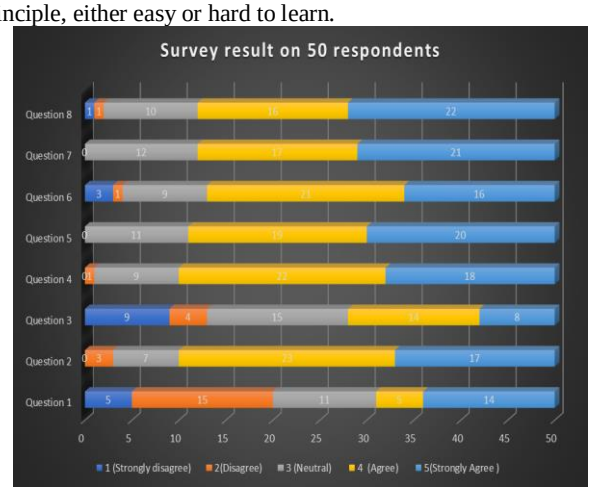


Fig. 7. Survey results on the questionnaires from 50 respondents

On the second question, most of the respondents stated that the Block Diagram Intelligent Learner educational kits are related to the topic taught in the Control Principles subject. The results show 46% of the respondents agree with the question, 34% of the respondents strongly agree, and 14% of the respondents' neutral with the statements. Only 6 % disagree that the kit is related to the topic. Fig 4.7 showed the graph for question item of Educational Kit is related to the topic. The third question of the survey shows that nine respondents stated strongly disagree and four disagreed with the statements while eight of the respondents strongly agree, and fourteen of the respondents agree.

Meanwhile, fifteen of the respondents were neutral with the statements. Eighteen of the respondents strongly agree with the fourth question asked in the questionnaires. While twenty-two of the respondents agree with it and only nine of the respondents have a neutral opinion, one respondent disagrees. The fifth question stated the positive side of using the Block Diagram Intelligent Learner Educational kit to save students' learning time. This can help the student to understand the topic faster while reducing studying time. The results show 40% of the respondents strongly agree, 38% of the respondents agree, and only 22% of the respondents have a neutral opinion with the statements. On question sixth, the result shows that 16 of the respondents strongly agree, 21 of the respondents agree, and 9 respondents have a neutral opinion on the statement. This concludes that educational kits provide an easy way to understand the topic. Only three of the respondents strongly disagree, and one disagrees with the idea. Overall, most respondents believe that the educational kit provides deep knowledge by answering question number seventh. 42% of the respondents strongly agree, 34% agree, while 24% of the respondents have a neutral opinion. For the final question, the result shows 22 of the respondents strongly agree, and 16 of the respondents agree that the educational kit is one of the important teaching aids that the lecturer should bring to improve student understanding of the topic in the Control System. The student becomes more interactive with the kits thus make themselves feel easier to learn and understand. Only one of the respondents strongly disagrees and disagrees, while ten respondents have a neutral opinion about the educational kit's role.

As a summary of the survey, most respondents agreed that the kits would help to improve learning effectiveness, save students learning time, improve learning and to understand this topic, provide deep knowledge to understand the topics, and also agree that the kits will play an important role to understand topics in Control System. The only part that the number of respondents who disagree is higher was for questions one and three. They disagree as the Control System is an interesting subject, and some of them found the kits were difficult to use.

IV. CONCLUSIONS

An educational kits prototype for learning block diagram topics taught in the Control System subject is successfully developed, verified, and tested, and acquired the survey data from multiple users. This prototype is important as it will increase students' interest, develop students' psychomotor learning and improve students' understanding of the related topics. Further improvement can be made in the future to the prototype base on the users' feedback.

ACKNOWLEDGMENT

The authors would like to express the gratitude to the Faculty of Electrical Engineering, Universiti Teknologi MARA (UiTM), Cawangan Shah Alam, Faculty of Electrical Engineering, Universiti Teknologi MARA (UiTM), Cawangan Johor, Kampus Pasir, and also 600-IRMI/FRGS 5/3 (154/2019) for providing the financial support throughout this research.

REFERENCES

[1] Zheng, W., Yang, Z., Feng, L., Fu, P., & Shi, J.,APP Design of Energy Monitoring in Smart Campus Based on Android System. International Journal of Online and Biomedical Engineering (iJOE), 15(05)(2019) 18-27.

[2] Feng, L., Yang, C., Zheng, W., & Fu, P., Android APP Development of Remote Wireless Automatic Meter Reading System based on 3G. International Journal of Online and Biomedical Engineering (iJOE), 13(02)(2017) 18-33.

[3] Sayono, J., Jauhari, N., Ayundasari, L., & Sulistyo, W., Development of Projo Bale Model Based on Android Application in History and Local Wisdom Studies of Malang. International Journal of Emerging Technologies in Learning (iJET)., 15(7)(2020) 4-16.

[4] Mustapa, R. F., Abidin, A. F. Z., Amin, A. A. N. M., Nordin, A. H. M., & Hidayat, M. N., Engineering is fun: Embedded CDIO elements in electrical and electronic engineering final year project. In 2017 IEEE 9th International Conference on Engineering Education (ICEED) (2017) (1-6). IEEE.

[5] Faseh, M. H. A. H. A. M., F. N. Ismail, M. A. Majid, A. F. Z. Abidin, Z. M. Yusoff, R. Rifin, K. K. Hasan, N. M. Ali, and Z. I. Rizman.,E-PLC: the development of a programmable logic controller trainer that translates mnemonic codes to hardware simulation., Journal of Fundamental and Applied Sciences 10(2)(2018) 499-513.

[6] Anuar, A., A. F. Hussin, M. A. Majid, A. F. Z. Abidin, Z. M. Yusoff, K. K. Hassan, N. M. Ali, M. H. Harun, and Z. I. Rizman.,E-tester: the development of an electronic board that checks commonly used Arduino-based electronic components and modules., Journal of Fundamental and Applied Sciences 10(2)(2018) 514-523.

[7] Zakaria, M. F. Z. M., Siti Asma Che Aziz, Amar Faiz Zainal Abidin, Mohd Anuar Adip, Norain Rahim Wan Haszerila Wan Hassan.,The Development of an Electronic Educational Quiz Board that Test Student Knowledge on Control Principle's Second Order Transient Response by Using DC Motor Speed Control as Application., ARPN Journal of Engineering and Applied Sciences 13(13)(2018) 4079-4082.

[8] Abidin, A. F. Z, et al.,e-Flowchart: An Electronic Educational Quiz Board that Test Student Knowledge on C Programming Concept using Flowchart Command, ARPN Journal of Engineering Applied Sciences, 13(23) (2018) 9081-9085.

[9] M. I. Z. M., Zabidi, et al.,e-Transform: High School Educational Kit for Learning Mathematical Transformation, Proceeding of Innovative Teaching and Learning Day 2018, (2018).

[10] K. A., Kadiran, et al.,E-Water Level: Educational Kit for Learning Control System by Using Water Level Application,Proceeding of Innovative Teaching and Learning Day 2018, (2018).

[11] Hafizan, A. F., Abidin, A. F. Z., Suhaimi, N. Z. N., Mustam, M. M., Sukarman, F., Kadiran, K. A., Rifin, R., E-Congkak: The Development of an Electronic Congkak Board Game to Promote Traditional Board Game to Younger Malaysian Generation.

ARPN Journal of Engineering and Applied Sciences, 13(24)(2018) 9624-9630.

[12] Asraf, M. H., Dalila, N. K., Zakiah, M. Y., Faiz, A. Z., & Nooritawati, M. T. (2018). Computer Assisted E-Laboratory using Lab VIEW and Internet-of-Things Platform as Teaching Aids in the Industrial Instrumentation Course. International Journal of Online Engineering, 14(12)(2018) 26-42.

[13] Rozani, I. A., Abidin, A. F. Z., Karis, M. S., Nizam, M. N. M., Azahar, A. H., Harun, M. H., ... & Shah, B. N., E-OTHELLO: The Development Of An Electronic-Hardware Version Of Traditional Othello Board Game. ARPN Journal of Engineering and Applied Sciences, 14(3)(2019).

[14] Karis, M. S., Abidin, A. F. Z., Nizam, N. Z., Saad, W. H. M., Ali, N. M., & Shokri, A. S. M., Laplace Circuit Solver: A Tactile-based Educational Electronic Board Simulator for Producing Electrical Circuit's Laplace Transform Equation. International Journal of Recent Technology and Engineering (IJRTE), 8(3)(2019).

[15] Halim, M. F. A., Idrus, N. A. I., & Abidin, A. F. Z., Develop an Electronic Educational Kit with Android Application that Test Student Knowledge in Series and Parallel Resistor for Electrical Circuit (Res-Circuit Quiz Board). International Journal of Innovative Technology and Exploring, 8(9)(2019) 1-5.

[16] Ab Halim, M. F. M., Nor, A. M. M., Badari, A. A., Abidin, A. F. Z., Kadiran, K. A. Adam, S. H. Mohammad, and M. H. Harun.,Educational kit the development of an electronic quiz board that tests engineering students' knowledge on resistors concept in an electrical circuit., International Journal of Recent Technology and Engineering 8(1)(2019) 202-207.

[17] R. Rifin, T. E. Fang, A. F. Z. Abidin, A. Adam, M. A. Majid, A. Zainuddin, S. H. Mohammad, M.H. Harun, Z. I. Rizman.,Examwiz: A Development and Implementation of an Android Based Examination,Journal of Fundamental Applied Science, 10(6)(2018) 965-976.