Development of Learning Kit and Module for a Technology Design (RBT) Subject: Insights From Needs Analysis

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The Asian Conference on Education 2022
Official Conference Proceedings

Abstract
The electronic design process included in the Malaysian secondary school syllabus pose challenges to the teachers as it requires teaching aids to facilitate more effective understanding and practice of the process. Therefore, this study aimed to identify key elements in the development of a Technology Design (RBT) learning kit for the electronic design topic of the RBT subject in the Malaysian secondary schools. This qualitative study used semi-structured interview protocol in conducting the needs analysis. Five teachers who were appointed as facilitators and had expertise in the field of electronics were selected via purposive sampling. The interview results were transcribed and analyzed using Atlas.ti software. Based on the needs analysis, all five respondents agreed that the subject of RBT needs teaching aids especially for the electronic design topic. They argued that existing learning kits use non-universal programming languages. Therefore, they suggested that the proposed learning kit must use open-source programming and allow easy references on the internet. All respondents chose the Arduino type microcontroller in the production of electronic design projects because it is open-source and universal. The implications of this findings call for relevant parties including teachers, researchers and the Ministry of Education to consider that the development of learning kits and modules for RBT learning kits for electronic design topic should be straightforward, simple to understand, and compact.

Keywords: Electronic Design, Learning Kit, Teaching Aids, Needs Analysis, Semi-Structured Interview, Microcontroller

Introduction

Economically speaking, the world is increasingly challenging especially in terms of using technology in everyday life. Technology is seen as a basis for economic growth, however economic growth based on weak technology will falter in today's scenario (Raja and Nagasubramani 2018). Technologically advanced countries need to produce skilled workforce that not only have sensitivity to its professionalism but are always ready to accept change (Sidin et al. 2001). Empowering technology in education in all walks of life is one of the key efforts in the formation of tech countries. Therefore, one of the government's efforts is to introduce technological subjects into a secondary school syllabus.

Design and Technology (RBT) is one of the subjects offered in primary and secondary schools aimed at providing students with awareness and exposure to technology. RBT subjects can also foster students to think, give ideas and thus produce technology -based innovation products. The RBT subject has an electronic subtopic where students will learn about microcontroller, inputs, outputs, and programming that are important elements in the production of technical projects. However, this electronic topic is more difficult to understand than other topics as it involves programming and installing electronic circuits. This topic also involves practical where it requires hardware and software that allows students to design electronic projects starting from designing circuits, simulating, connecting input circuits, outputs, and microcontrollers, writing programming and testing circuit functionality. The process will be complicated if there are no special guides or references related to this topic. The selection of inappropriate hardware and software also affects the teaching and learning process of this topic. Thus, this topic requires teaching aids where it can help students learn electronics in the process of designing electronic circuits, building simulation circuits, connecting input circuits and outputs on microcontroller, learning programming, and then testing on circuits built.

The teaching aids developed are available for use directly in the production of electronic design projects to be built by students. Unfortunately, the characteristics or elements of the learning kits needed by teachers to facilitate the teaching and learning process are still unclear. Therefore, this calls for a study on the development of teaching aids for electronic topics for secondary school students focusing on the learning kits for electronic topics in RBT subjects. This study is essential in assisting better understanding among teachers about the development process that involves design processes of electronic circuit design and programming arrangement.

Objectives

This study was conducted to determine the need analysis for learning kit on knowledge of electronic design in Design and Technology (RBT) subjects for high school students. The specific objectives to be achieved are as follows:

1. Identify important elements in the development of the Learning Kit for the RBT Electronic Design topic in the Malaysian Secondary Schools.
2. Identify the technical features needed in the process of designing the learning kit for the RBT subject's electronic design topic.

Methodology

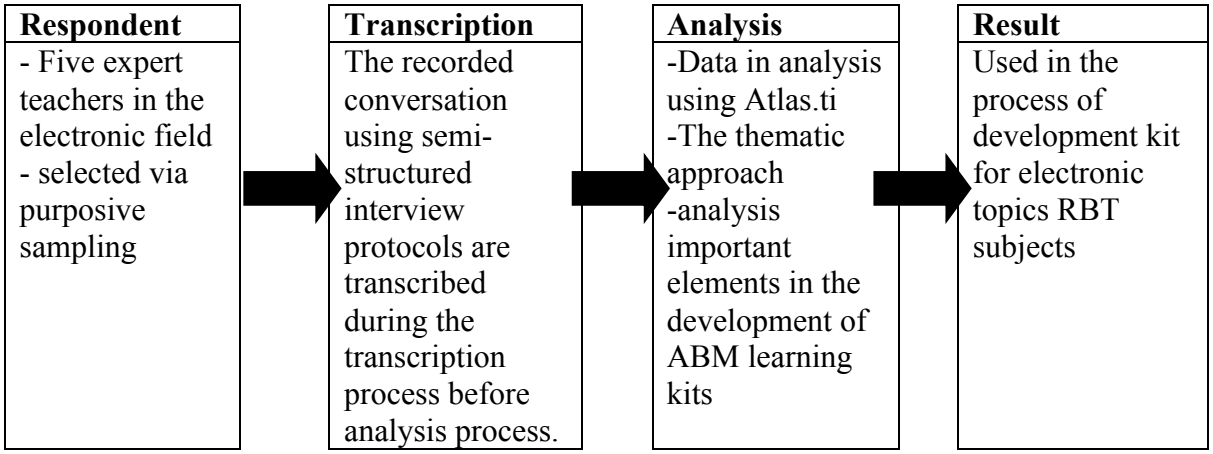

Figure 1: Summary of the research methodology

As shown in Figure 1, this study is a qualitative study involving 5 respondents or participants who were experts or main coaches among the electronic design subject teachers. The five teachers selected have expertise in the electronic field and have taught the subject for more than 5 years. They were selected as the sample for the study according to the purposive sampling procedure.

The researchers used a set of semi-structured interview protocols as the research instrument to obtain data on the module construction needs and electronic design learning kits. While the structured interview has a formalized, limited set of questions, the semi-structured interview on the other hand is flexible, allowing new questions to be brought forward during the interview as a consequence of what the interviewees have said (Ruslin et al. 2022).

Upon receiving their consent and confidentiality, the interviews with the five respondents were recorded and transcribed during the transcription process. After the interview, the analysis of the interview transcript was performed to see the meaning and feedback of the study participants. The theme analysis of the entire transcript was performed by comparing it from all respondents of the study using Atlas.TI 9 software which is a tool for data analysis to assist the researchers in managing the various data (Afriansyah et al. 2019). The raw data obtained from the interview transcripts were analyzed according to the themes and categories outlined in the study objectives using the thematic method.

Results and Discussion

Thematic analysis from the semi-structured interviews were conducted as part of the qualitative interview data analysis. The study participants were provided opportunity to express their own opinions during this semi-structured interview. The results of these findings were used in the development of the modules and learning kits for the RBT subject topics that will be used by secondary school teachers and students in Malaysia. The characteristics of the needs identified in developing electronic design learning kits are based on several technical requirements because of the transcript analytical processes divided into three themes which is the type of microcontroller and the language used, the design requirements and order of the learning kit and the requirements of the learning kit guide, through the data analysis conducted with the help of Atlas.TI 9. The suitability of ATLAS.ti for qualitative study can be gauged from the fact that it is primarily used for content analysis

and analyzing complex textual data (Gulsia and Yadav 2023). Figure 2 shows the results of the analysis using the Atlas.TI 9 sofware.

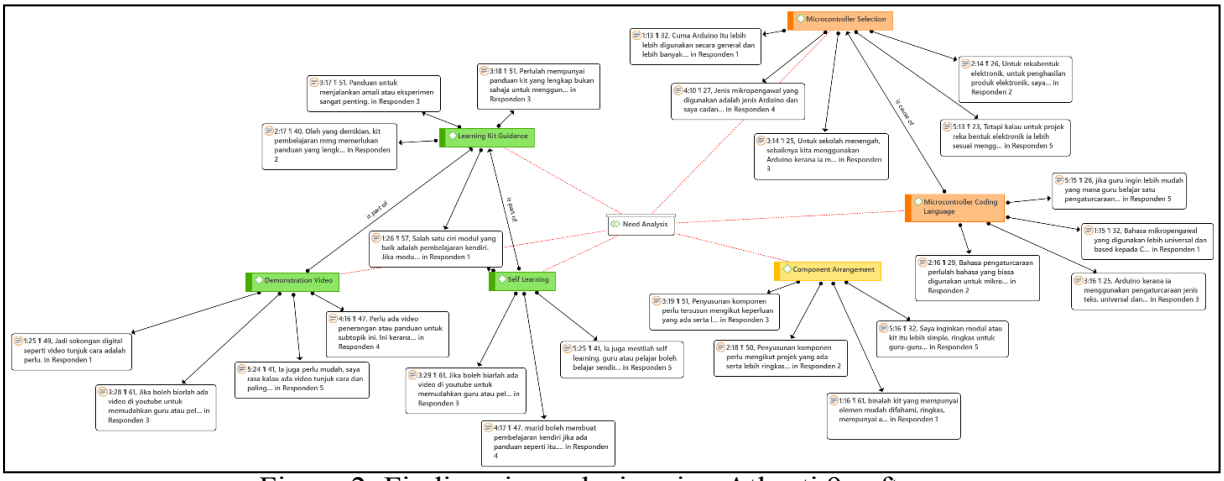

Figure 2: Findings in analysis using Atlas.ti 9 software

The findings show that there are three main themes that researchers need to consider. The selection of microcontrollers is closely related to the selection of programming languages. This is because each microcontroller has its own type of compatible programming. In addition, the design and arrangement of components should also be considered where the proper component arrangement will produce a more practical learning kit that will be carried out in the classroom. The learning kit also needs to have a handbook or reference that has self-learning features and complete with video demonstrations. These themes will be described in more details in the following subtopics.

Theme 1: Microcontroller Type Requirements and Programming Languages Used

The choice of microcontroller and programming language used is an important element in designing a learning kit for electronic teaching and learning processes. This is because the selection of microcontrollers or inaccurate programming languages will affect students and teachers. Therefore, understanding the concepts related to the microcontrollers is important for choosing the best hardware. There are many different types of microcontroller and application development cards on the market, it is observed that students have difficulty in where to start (Güven et al. 2017). The findings of this study show that all respondents agree that the type of microcontroller that will be used is open source and easy to find references. They also agree that the programming language used must be universal in which the language used must be widely used throughout other countries. All respondents also think that Arduino -type microcontrollers are ideal for use in the development of this learning kit. This is because the Arduino-type microcontroller uses the Base C ++ programming language which is widely used for the production of electronic projects and innovation. For example, Respondent 1 (R1) says that:

R1: "*Bahasa mikropengawal yang digunakan perlu lebih universal dan based kepada C yang digunakan secara meluas*."
(The language of microcontoller used should be more universal and based to the widely used C.)

Arduino's constructor programming code is built in C. This language is quite simple to learn, and it comes with a special generalised development environment that enables even those

without a high level of software development expertise to create unusual projects (Tukhtanazarovich, 2021).

Meanwhile, Respondents 3 (R3) and 4 (R4) said the selection of Arduino -type microcontroller was best because of its use of use and examples of programming on the Internet.

R3: "*Untuk sekolah menengah, sebaiknya kita menggunakan Arduino kerana ia menggunakan pengaturcaraan jenis teks, universal dan open source. Rujukan pula banyak terdapat dalam internet membolehkan murid atau guru belajar secara sendiri.*"
(For secondary school, we should use Arduino as it uses text-type, universal and open-source programming. Many references are available on the internet allowing students or teachers to study by self -learning.)

R4: "*Jenis mikropengawal yang digunakan adalah jenis Arduino dan saya cadangkan juga jenis ini yang terbaik. Ini kerana mikropengawal jenis ini lebih universal dan open source. Bila open source jadi ramai yang menggunakannya. Jadi contoh-contoh projek dan pengaturcaraannya banyak terdapat di internet*."
(The type of microcontoller used is Arduino type and I also suggest this type of best. This is because this type of microcontroller is more universal and open source. When the open source it becomes a lot of use. So, examples of projects and programming are available on the internet.)

Theme 2: Design and Learning Kit Components Needs

When asked about what the teacher needs for the learning kit design in the RBT teaching and learning process of electronic design topics, the respondents said that they needed a structured and simple learning kit. Three respondents said the component of the learning kit components should be simpler to facilitate the understanding of both students and teachers. For example, according to Respondent 2 (R2) below, the design kit should be in a simple project and has three elements that can interest students namely movement, sound, and light. Furthermore, maintenance of the kit should be kept minimal, requiring no more than a simple replacement of any damaged components. Furthermore, it is again necessary to keep functionality minimal in order to avoid overloading the student with too much information and facilitate the understanding of basic concepts (Junior et al. 2013). The learning kit is aims to make it easier for students to learn and understand the subject matter (Kob et al. 2019).

R2: "*Penyusunan komponen perlu mengikut projek yang ada serta lebih ringkas. Murid akan tertarik kepada tiga komponen ini iaitu, bergerak, berbunyi dan menyala. Jadi ouput untuk ABM tersebut pelulah adalah 3 komponen tersebut yang bleh menarik minat murid untuk belajar*."
(Component arrangement needs to be in accordance with existing projects and is simpler. Pupils will be attracted to these three components, namely, moving, sounding and lighting. So the OUTPUT for the learning kits is the three element that can attract students to learn).

The same response was also given by Respondent 4 (R4).

R4: "*Saya inginkan modul atau kit itu lebih simple, ringkas untuk guru-guru supaya guru boleh menggunakannya dengan lebih mudah. Ia perlulah mudah untuk difahami disebabkan oleh modul dan kit yang lebih ringkas itu tadi.*"
(I want the module or kit to be simpler, simple for teachers so that teachers can use it more easily. It should be easy to understand because of that simpler module and kit.)

Theme 3: Learning Kit Usage Guide Requirements

All five respondents said they needed a guide or handbook on the use of the learning kits to be developed. This is because the learning kits on the market do not have a complete and appropriate handbook that they want to teach in the classroom. They recommended that the modules detail out how to teach skills using the learning kits. Among the suggestions presented are detailed steps, methods, techniques, analogies and examples of appropriate applications.

Four respondents suggested that a handbook or module developed with the Learning Kit had a video demonstration to facilitate the teaching and learning process. For example, Respondent 3 (R3), Respondent 4 (R4) and Respondent 5 (R5) stated that video suggestions for students to learn on their own.

R3: "*Jika boleh biarlah ada video di youtube untuk memudahkan guru atau pelajar access agar senang kita belajar secara kendiri. Jadi murid tidaklah mengharap pada buku teks sahaja.*."
(If possible, there is a video on YouTube to make it easier for teachers or students to access it to be easy to learn on our own. So students not refer on textbooks only.)

R4: "*Perlu ada video penerangan atau panduan untuk subtopik ini. Ini kerana murid boleh membuat pembelajaran kendiri jika ada panduan seperti itu. Jadi murid tidak bergantung sepenuhnya kepada guru*."
(There should be a description video or guide for this subtopic. This is because students can do self -learning if there is such a guide. So students are not entirely dependent on the teacher.)

R5: "*Ia juga perlu mudah, saya rasa kalau ada video tunjuk cara dan paling penting adalah simple. Ia juga mestilah self learning, guru atau pelajar boleh belajar sendiri.*"
(It also needs to be easy, I think if there is a video demonstration and most importantly it is simple. It must also be self learning, teachers or students can learn on their own.)

Conclusion

The findings of the study and discussions highlight that teachers need the RBT subject learning kits for electronic design topics with important elements that can help facilitate the teaching and learning process. The technical elements of the discussion should be considered in the learning kits development process. The resulting learning kits also need to have a clear handbook or module because electronic topics are topics that involve skills and practicality. The learning kits are aimed at enhancing the achievement of RBT subjects in electronic design topics as well as improving skills in the development of electronic design projects. Finally, the learning and teaching activities generated through the suggestions raised in the learning kits developed can be used as an effective teaching and learning guide for teachers to facilitate STEM learning among students in the Malaysian secondary schools.

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