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Development Of Roboteacher Module For The Topic Of Mechatronic Design In The Subject Of Design And Technology Form 3

(Pembangunan Modul RoboTeacher Bagi Topik Reka Bentuk Mekatronik Dalam Mata Pelajaran Reka Bentuk Dan Teknologi Tingkatan 3)

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ABSTRACT

This study aims to see the need and effectiveness of the RoboTeacher Module Development for learning Mechatronics Design Form 3. The RoboTeacher Module Development is a teaching aid provided to assist learning and facilitation sessions (PdPc) in the classroom. The main objective of the study is to analyze the development needs of the module, then develop the module and the module gets an evaluation from the experts where they give opinions and suggestions for improvements to the modules that have been developed. This study uses an interview approach and the WATERFALL Model has been applied in the development of modules for this study. This study uses interview instruments to obtain relevant information and data to answer objectives 1 and 3 in this study. This interview was conducted with 3 experts who are in the field of electronics and this interview uses semi-structured questions to verify the development of the RoboTeacher Module. As a result of the interview findings, the researcher found that the RoboTeacher Module helps teachers in the PdPc process. The improvement that can be done is to create a teacher's version by carrying out 21st century learning activities, adding components such as a Touch Sensor for more challenging and more interesting module colors.

Keywords: RoboTeacher Module, Mechatronic Design, Design and Technology Education, Form 3, 21st Century Learning

ABSTRAK

Kajian ini bertujuan untuk melihat keperluan dan keberkesanan Pembangunan Modul RoboTeacher bagi pembelajaran Reka Bentuk Mekatronik Tingkatan 3. Pembangunan Modul RoboTeacher ini merupakan bahan bantu mengajar yang disediakan bagi membantu sesi pembelajaran dan pemudahcara (PdPc) di dalam kelas. Objektif utama kajian adalah menganalisa keperluan pembangunan modul, kemudian membangunkan modul dan modul tersebut mendapat penilaian dari pakar di mana pakar memberikan pendapat dan cadangan penambahbaikan terhadap modul yang telah dibangunkan. Kajian ini menggunakan pendekatan temu bual dan Model WATERFALL yang telah diaplikasikan dalam pembangunan modul bagi kajian ini. Kajian ini menggunakan instrumen temu bual bagi mendapatkan maklumat dan data yang berkaitan bagi menjawab objektif 1 dan 3 dalam kajian ini. Temubual ini dilakukan terhadap 3 orang pakar yang berada dalam bidang elektronik dan temubual ini menggunakan soalan separa berstruktur untuk mengesahkan terhadap pembangunan Modul RoboTeacher. Hasil dapatan temubual yang telah diperolehi, pengkaji mendapati bahawa Modul RoboTeacher membantu guru dalam proses PdPc. Penambahbaikan yang boleh dilakukan adalah dengan mewujudkan versi guru dengan menjalankan aktiviti pembelajaran abad ke-21, menambah komponen seperti Touch Sensor untuk lebih mencabar dan warna modul yang lebih menarik.

Kata kunci: Modul RoboTeacher, Reka Bentuk Mekatronik, Pendidikan Reka Bentuk dan Teknologi, Tingkatan 3, Pembelajaran Abad ke-2.

INTRODUCTION

The Ministry of Education Malaysia (MOE) has introduced a new subject namely Design and Technology, widely known as *Reka Bentuk dan Teknologi (RBT)* in schools all over the nation to replace the previous Integrated Living Skills subject or *Kemahiran Hidup Bersepadu*. This new RBT subject is required to be taken by all Form 1, Form 2 and Form 3 students meanwhile for Form 4 and Form 5 students, there will be an Invention subject or *Reka Cipta (RC)* as an elective. In 2016, the Ministry of Education Malaysia (MOE) released a Secondary School Standard Curriculum or *Kurikulum Standard Sekolah Menengah (KSSM)* specifically for *the* RBT subject and had been carried out gradually in the following year, 2017. This was mainly due to replacing the Integrated Living Skills subject or *Kemahiran Hidup Bersepadu* which had been taught in schools for over three decades since 1988. According to this newly released curriculum, the RBT subject is also seen as a catalyst for producing more students with good communication skills and the ability to generate fresh ideas in creating new products. Besides, it is also used to observe students' efficacy whereby their thinking skills are on the desired level as mentioned in the Malaysia Education Blueprint 2013-2025 or *Pelan Pembangunan Pendidikan Malaysia 2013-2025 (PPPM)*. Moreover, this KSSM specifically for the RBT subject also highlights a focus on four domains namely Design and Technology Domain or *Domain Reka Bentuk dan Teknologi*.

Science, Technology, Engineering and Mathematics (STEM) is one of the education approaches that stresses the integration of Science, Technology, Engineering and Mathematics in lessons. The main objective of integrating STEM into Malaysian education is to elevate students' interest and skills specifically in this field, subsequently preparing such competent individuals who are able to endure all the challenges and demands of the rapidly developing world driven by technology and digitalisation. In Malaysia, STEM education has been introduced in the National Education Curriculum and a lot of initiatives have also been taken by the higher-ups to strengthen this aspect. Furthermore, there is an urgent need to integrate STEM into Malaysian education because the subject undoubtedly plays a pivotal role in today's industry and even the word Science itself is originally taken from '*scientia'*, a Latin word which refers to knowledge that is seen as a powerful tool for making changes.

However, contemporary students find RBT as one of the most difficult subjects to master in schools. This is because this subject undeniably introduces a lot of complicated concepts, which results in the students being unable to grasp the lessons well. Moreover, this subject also requires students not only to memorise and analyse but also to have good technical skills, and problem-solving skills as RBT subject offers subtopics namely Electronic Design and Mechatronic Design whereby the students must have a strong base of knowledge regarding electronics beforehand to ensure they are able to comprehend these subtopics better. This is crucial because these subtopics require the students to identify the microcontroller and the microprocessor, explain the parts and the components of the microcontroller, produce a sketch of the electronic circuit and have adequate knowledge to connect the electronic circuit as well as understand the whole electronic system while learning the Form 2 Electronic Design topic and Form 3 Mechatronic Design topic. Besides, there is also a utilisation of long coding in this subject which directly causes the students to have difficulties in digesting the whole process that they have learned. In fact, there are also some of the teachers that still have not fully mastered the Electronic Design topic.

Additionally, there is a shortage in terms of specific modules that are used to teach both Electronic Design and Mechatronic Design topics. Hence, teachers are unable to set a focus towards the projects that will be distributed to the students. Having a lack of aforementioned specific modules definitely affects the whole Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* of the RBT subject. "While conducting a PdPc on the Electronic Design topic under the RBT subject for Form 2 students and the Mechatronic Design topic under the RBT subject for Form 3 students, a conflict in regards to the utilisation of microcontroller development board arose" (Yusriza Mohamad Yusif, Afida Ayob and Mohamad Hanif Md Saad, 2021). Moreover, the coding used in this subject is also found to be difficult for students to understand. As evidence, Yusriza Mohamad Yusif, Afida Ayob and Mohamad Hanif Md Saad (2021) mentioned that students are less exposed to coding languages like Python and C++ which can be learned through open source.

The Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* is one of the interactions that occurs in the classroom between students and teachers. Throughout this whole session, teachers act as facilitators who make sure that the learning process goes smoothly for students which includes facilitating the process of gaining knowledge, mastering the skills and characters as well as moulding positive behaviours and beliefs. In other words, learning

is a process to assist students in gaining knowledge and applying it accordingly. A good learning session should consist of two-way communication between students and teachers whilst integrating activities and knowledge outside of the classroom to achieve the learning objectives. "Students are not only given knowledge in one way but they also should be boosted to ensure an effective learning output can be obtained" (Kamelia, 2019).

MODULE UTILISATION IN TEACHING DESIGN AND TECHNOLOGY OR REKA BENTUK DAN TEKNOLOGI (RBT) FOR FORM 3 STUDENTS

According to Mayudho and Achmad Supriyanto (2020), "Technology has rapidly evolved and it does have an influence towards the education field". Therefore, 21st-century learning styles are veritably suitable for enhancing students' development as Malaysia approaches Industrial Revolution 4.0 (IR4.0). Every educator should look into making a paradigm shift and preparing themselves with sufficient skills as well as knowledge to face the transformation specifically in education these days (Noor Lela Ahmad, Shoo Sin Looi, Hariyaty Ab Wahid and Rohaila Yusof, 2019). In conjunction with the development that is currently happening, Malaysia has also highlighted a vision of being ranked in the top one-third of the Trends in International Mathematics and Science Study (TIMSS) assessment and Programme International Student Assessment (PISA) by 2025 (Ministry of Education Malaysia, 2016).

The Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)* is required to be taken by all Form 1, Form 2 and Form 3 students in schools all over Malaysia. These lower-secondary students must master all the skills learned in this subject, especially those who decide to take an elective subject, namely the subject or *Reka Cipta (RC)* as they enter Form 4 and Form 5. It is common for students coming from the front classes to find this RBT subject easy to comprehend and this is also well-elaborated by one of the teachers who teaches RBT subject through an interview conducted previously. This teacher found that this subject requires students who have interest and sufficient skills to successfully understand the whole lesson because their thinking skills will be tested through this RBT subject. For instance, they have to always think from a wider perspective and produce fresh ideas in order to solve particular problems.

Nonetheless, the significance of both Science and Mathematics subjects should not be taken lightly as these subjects also have so much impact on today's industrial demands, especially in this digitalisation era. By being one step forward in fulfilling current industrial demands, the country's finances will also be positively influenced. Thus, the drastic initiative moved by the government in introducing an approach to the education of Science, Technology, Engineering and Mathematics (STEM) is seen as a wise decision because adequate early exposure is indeed crucial to give to all students in this country since they are in primary schools. Besides, this initiative is also believed to be a game-changer in bringing this nation to the same level as the other developing countries all around the globe.

The development of microcontrollers from Lego modules is envisioned to become a pioneer in leading the education field in Malaysia. By applying Lego with microcontroller technology, students are exposed to practical perspectives which include coding, engineering and robotics through interesting and effective ways. Moreover, looking at the high demand for STEM education, this approach is seen as a catalyst for producing generations that specialise in the technology field. The development of microcontrollers from Lego modules specifically in the Malaysia landscape not only contributes to new learning experiences among the students in this nation but also helps develop the potential of individuals, which subsequently improves the country's technological development overall.

Therefore, the development of microcontrollers from Lego modules should be further studied for its effectiveness in the Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* for the Form 2 Electronic Design topic and Form 3 Mechatronic Design topic. Mazihah Othman (2013) mentioned that a variety of teaching materials in education have indirectly facilitated the whole teaching and learning process that occurs in the classroom. Thus, this research is conducted to give insights and exposure to younger generations to pursue the electronic and mechatronic engineering fields. Apart from that, the purpose of this research is also to encourage more interest among the younger generations to deeply immerse themselves in these fields.

Most future teachers these days have been exposed to the importance of utilising teaching aids in the classroom since they are in the university. This is because teaching aids are indeed helpful in conveying lessons effectively by using interesting materials. Thus, these future teachers are also given with innovative inputs and knowledge that can be used to assist them in producing more teaching aids that are not only interesting but also relevant in this modernised era. This can be seen in how most local education institutions

have started to realise this matter and act accordingly to encourage these future teachers' creative minds to create more captivating learning experiences which consequently makes education in Malaysia of top-notch quality. According to Nur Syafiqah Isa and Nurul Nazirah Mohd Imam Ma'arof (2018), teaching aids or *Alat Bantu Mengajar (ABM)* are equipment used by teachers to assist them in delivering lessons.

Robotics or robot devices are commonly used for multiple applications in the education field. Danahy et al. (2014) stated that robotics is one of the branches that connect students around the world with effective learning processes through the application of interesting and helpful teaching aids. By providing such interesting and practical instructions, students can come up with coding for the robot devices, which significantly shows that they are also able to apply what they have learned while solving problems (Johnson, 2003; Malec, 2001; Yuan et al.,2019). Research that focuses on exposure to robotics and robot devices indirectly contributes to higher-quality education, which simultaneously motivates students out there to delve deeper into the Science, Technology, Engineering and Mathematics (STEM) field (Chen & Chang, 2018; Hendricks et al., 2012; Nugent et al., 2010).

Addido et al. (2022) and Nall (2016) addressed that a curriculum based on robotics can assist students in comprehending scientific abstract concepts and obtaining practical knowledge through hands-on practices. However, not all the research related to education based on robotics and electronics ends up with positive outcomes and this can be proved through a statistic that shows the particular students' excellence does not positively improve specifically in the electronics and robotics fields (Altin & Pedaste, 2013; Chen & Chang, 2018). A ten-year research on education based on robotics found that less research focuses on the students' learning outcomes as well as research that highlights the students' positive outcomes of learning STEM (Altin & Pedaste, 2013; Benitti, 2012; Chen & Chang, 2018; López-Belmonte et al., 2021). Thus, this research is conducted to show that STEM education plays a pivotal role in assisting all students who have strong interests in this field to gain sufficient exposure.

Besides that, the conventional learning method is found to be irrelevant to be applied in a Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* these days, especially in the Technical and Vocational Education and Training (TVET) field. Eddy Azhar Jalani, Muhd Khaizer Omar, Thinagaran Perumal (2023) stated that every aspect of the country faces challenges due to rapid technological development including the economic and industrial aspects. Aside from that, the education field was also directly impacted by this aforementioned technological development, especially the TVET field, which has been a foundation for producing more workforce to ensure that Malaysia remains relevant in the eyes of the world. Therefore, students' readiness, an adequate number of educators and detailed plans from the TVET institutions' sides should be given thorough attention in facing the Industrial Revolution 4.0 (IR4.0).

Research conducted by Noordin (2018 and 2019) implies the modular method of teaching that applies the mastery learning strategy managed to fix students' expectations regarding the particular concepts learned and simultaneously left positive impacts on their academic achievements. This modular method of teaching is also proven to be one of the most effective teaching methods that has successfully helped students improve their existing knowledge of the particular concepts learned (Noordin, 1997). This is also well supported by the research study conducted by Siheset et al. (2017), which concluded that the modular method of teaching is not only suitable to be used for self-learning but also used as the teaching aid in any teaching and learning activity.

APPLICATION OF THE ROBOTEACHER MODULE IN TEACHING FORM 2 ELECTRONIC DESIGN TOPIC AND FORM 3 MECHATRONIC DESIGN TOPIC

"The modular method of teaching is a type of structured teaching whereby all the syllabi are well-organised according to the particular sequences or learning stages" (Asran et al., 2017). These learning stages as mentioned previously are then divided into other smaller stages. This allows every student to follow the divided stages based on their own learning pace and abilities with the lesson can be improvised depending on the feedback received through assessments given at every stage. (Asran et al., 2017).

The demand for the development of a microcontroller module from Lego is further studied in this research as well as its effectiveness on the Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* for Form 2 Electronic Design topic and Form 3 Mechatronic Design topic. As stated by Mazihah Othman (2013), having various types of teaching materials utilised in the teaching process allows teachers to facilitate the whole lesson in the classroom. Besides that, this research also aims to give early exposure to the future generation in pursuing electronic engineering and mechatronic engineering

field, which simultaneously generates more interest towards these fields among young people.

The RoboTeacher Module development for RBT learning in schools is based on a few theories which include the constructivism theory, the cognitive theory and the creativity theory. These theories provide proper guidelines in the process of developing the module by considering all aspects such as individual improvement in terms of physical, mental, social and intellectual development. This is important for encouraging students to learn, enhancing their understanding of particular problems and promoting motivation within themselves. Therefore, it can be said that the RoboTeacher Module development which integrates the STEM elements is seen as a turning point in fulfilling the current demands in this digitalisation era.

It is undeniable that the RoboTeacher Module development helps students experience better learning, which subsequently helps them comprehend the lesson best. Not only that, but it also contributes to students' excellence and assists them in deciding on their future based on their desired streams to pursue upon entering Form 4. Thus, developing this module enhances students' interpretation of rapidly evolving technology and electrical systems these days. Besides, the RoboTeacher Module development is also seen as a medium to closely observe students' talents and potential as well as identify their interests at early stages.

The RoboTeacher Module does not only positively impact students but it is also believed to be able to help teachers who are still struggling with this electronic topic. This is said because this topic is considered new in the Design and Technology subject or *Reka Bentuk dan Teknologi* (RBT), Which is mainly due to the drastic changes that occur in the curriculum structure. Thus, teachers who previously taught the Integrated Living Skills subject or *Kemahiran Hidup Bersepadu* with less basic knowledge about the electronic topic are asked to teach this new RBT subject. Hence, the RoboTeacher Module development is indeed helpful for teachers as well because they are now provided with complete materials and references that can be used in teaching and learning sessions. As a result, students' potential and academic achievement can be also enhanced.

RESEARCH OBJECTIVES

This research aims to:

i. Analyse the demand for the RoboTeacher Module development.
ii. Develop a RoboTeacher Module for teaching the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)* for Form 2 and Form 3 students.
iii. Evaluate the validity of the RoboTeacher Module development.

RESEARCH METHODOLOGY

This research implies the qualitative approach that works as the main platform for the researchers to gather accurate data systematically. According to Othman (2001) in Hamidah (2007), the methodology is a systematic procedure in which the research approach and data analysis are combined to ensure that the researchers' performances can be optimised. This research mainly aims to analyse the demand for the RoboTeacher Module development and develop a RoboTeacher Module to teach the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)* for Form 2 and Form 3. Besides, it also aims to evaluate the validity of the RoboTeacher Module development.

Hence, a few samples are used in this research to obtain accurate data, which consequently achieves the aforementioned objectives. The first sample, which involves three teachers, is used to analyse the demand for the RoboTeacher Module development. Next, five experts, who act as the second sample, are asked to verify the module that has been developed by the researcher. The last sample for this research consists of another three secondary school teachers who are required to evaluate the experts' usability in the RoboTeacher Module development in teaching the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)* for Form 2 and Form 3 students as well as the Invention subject or *Reka Cipta (RC)* for Form 5 students. The sampling technique is being utilised to choose the samples that fulfil the specific criteria and have the potential to give desired data.

"The qualitative analysis consists of three data resources which include interview, observation and document analysis" (Kamarul Azmi Jasmi, 2012). A data analysis study for this research is made based on the information obtained through interview sessions conducted with all the selected respondents and also through the observation done in analysing the demand for the development of the RoboTeacher Module. The interview sessions with all the selected respondents are then transcribed and analysed according to the research questions that have been constructed beforehand by using the coding method. The research instrument used

is the inventory interview questions which consist of introductory questions, content questions and closure questions that are combined in a form. This form is then distributed to all the respondents.

Additionally, this research also utilises semi-structured interviews to collect reliable data. "In research, three types of interviews are commonly used to gather data which include structured interviews, unstructured interviews and semi-structured interviews" (Shuib, 2019). The unstructured interviews are more lenient compared to the structured interviews and the semi-structured interviews as they allow the respondents to give feedback freely according to the additional questions asked by the researchers. This means that most of the questions asked in the interview are based on the questions prepared earlier and also the follow-up questions that obey the guidelines of asking the respondents' opinions are usually posed to gain more insights into that particular topic (Shuib, 2019). This method is seen as way more flexible and does not only focus on one answer. The product development in this study is carried out using the Waterfall model. The Waterfall model consists of five phases: the requirements analysis phase, the design phase, the implementation phase, the validation phase, and the maintenance phase. Each of these processes is interrelated and has a significant impact on the creation of the module and the effectiveness of the teaching and learning process.

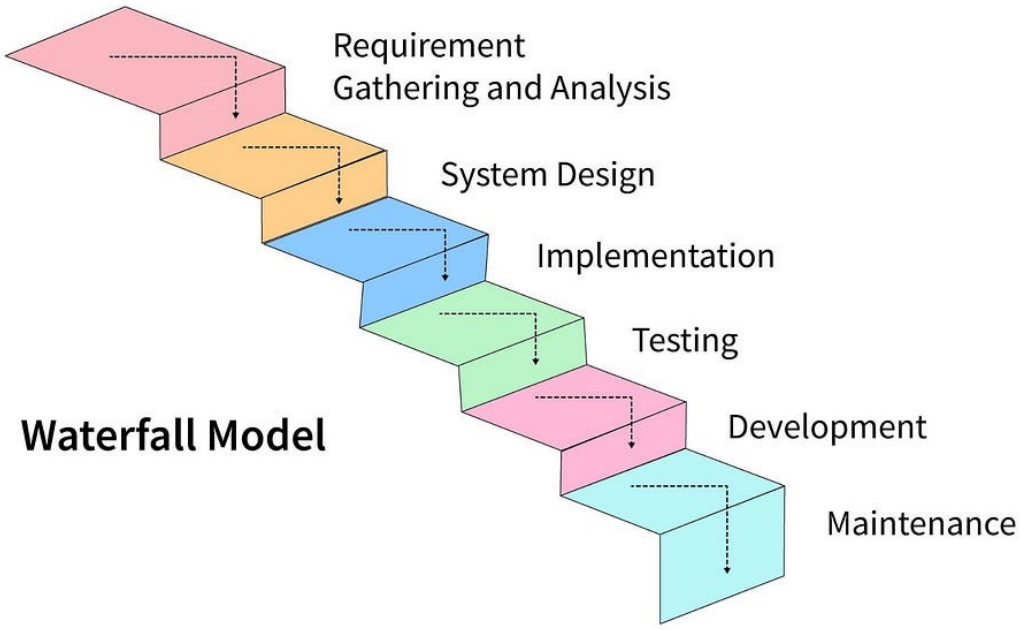

FIGURE 1. Waterfall Model

The assessment instruments are constructed according to the experts with skills in related fields to ensure suitable content that fulfils the research objectives can be easily reviewed. Therefore, the panel of validity experts consists of lecturers with different expertise from the Faculty of Technical and Vocational (FTV) at Universiti Pendidikan Sultan Idris (UPSI) are selected. Besides, they also have broader knowledge of innovation, mechatronics and technical and vocational education. All these panellists are appointed to give complete explanations regarding the research background, research concepts definitions, and operationalisation of the constructs involved as well as to review the prepared items. Every panellist is given a Research Instruments Validity Form to include any corrections, comments or suggestions on the related items.

RESEARCH FINDINGS AND DISCUSSION

Respondents' Background

The data collection method, which used the inventory Semi-Structured Interview Protocol, was conducted with three (3) respondents. They were selected based on their experiences and specific requirements. Two of them are teachers who have over five years of

experience in teaching the Integrated Living Skills subject or *Kemahiran Hidup Bersepadu* and the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)*. Another respondent is an educator who teaches practical practices for future RBT and RC teachers. Questions were posed to all respondents mainly about the teaching aids demand and criteria for teaching the Design and Technology subject or *Reka Bentuk dan Teknologi* (RBT), specially the Form 2 Electronic Design topic as well as the Form 3 Mechatronic Design topic.

Respondents in Group 1

TABLE 1. Biodata, Expertise and Respondent's Experience in Group 1 of Research

Respondent	Biodata, Expertise dan Experience
Respondent 1	Education Service Officer (Teacher) • 13 Years of Experience in Teaching • Design and Technology / Entrepreneurship Field
Respondent 2	Education Service Officer (Teacher) • 10 Years of Experience in Teaching • Design and Technology / Integrated Life Skills Field
Respondent 3	Assistant Vocational Training Officer • 10 Years of Teaching Experience in Electrics and Electronics Field • Expert in Power Electrical Engineering Field

Evaluations done on the semi-structured interview form regarding the RoboTeacher Module development gained verifications from three (3) experts. The data collection process was conducted on these three (3) experts who were selected according to their expertise, which included a teacher who has over five years of experience in teaching the Integrated Living Skills subject or *Kemahiran Hidup Bersepadu* and the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)*, a lecturer who is also an expert in the STEM education field as well as an educator who is experienced in constructing and practising practical for future RBT teachers. This expert validity process was conducted through semi-structured interviews to allow these selected experts to leave their comments or opinions on the developed products. The profiles of all of those who were involved in the interview are shown in the following Table.

Respondents in Group 2

TABLE 2. Biodata, Expertise and Respondent's Experience in Group 2 of Research

Respondent	Biodata, Expertise dan Experience
Respondent 1	Education Service Officer (Teacher) • 30 Years of Experience in Teaching • Design and Technology / Integrated Life Skills Field
Respondent 2	Assistant Electrical Engineering JA29 • 12 Years of Experience in the Electronic Field • Electronic Internship Coordinator
Respondent 3	University Lecturer DS54 • 10 Years of Teaching Experience in Technical and Vocational Field • Expert in the Technical and Vocational Education Field

ANALYSIS ON THE DEMAND FOR THE ROBOTEACHER MODULE DEVELOPMENT

The overall outcomes from an analysis done on the research findings indicate that the RoboTeacher Module is still relevant to be used in the Teaching and Facilitation session or *sesi Pengajaran dan Pemudahcara (PdPc)* for the Mechatronic Design topic in the Form 3 Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)*. This research entitled The Development of the RoboTeacher Module for the Form 2 Electronic Design topic and Form 3 Mechatronic Design topic is a type of study that focuses on producing a module based on the robot development practice known as Roboteacher.

In response to one of the research objectives, which is to analyse the demand for the RoboTeacher Module development, the findings obtained from the respondents indicate that it is crucial to arrange the module effectively. Besides, in the context of the Form 2 RBT subject, two respondents stressed the importance of infusing Science, Technology, Engineering and Mathematics (STEM) elements into this module. This is to ensure that the developed module is not only limited to teaching technical concepts but also integrating Science and Mathematics principles to offer a profound understanding among the students. Another respondent stated that this module should mainly focus on the technological element, which significantly shows the importance of introducing students to current technology and its application in daily life. As a result, students will be interested in delving deeper into other new fields.

Referring to the findings of the demand analysis, the majority of the samples agreed by giving positive responses towards the question for the first research objective, which is to analyse the demand for the RoboTeacher Module development. Aside from that, an analysis of the Curriculum and Assessment Standard Document, widely known as *Dokumen Standard Kurikulm dan Pentaksiran* (DSKP), was conducted to ensure that the developed module covers all the learning topics. Hence, the envisioned future of creating a 21st-century learning environment can be realised through the utilisation of the developed module in the classroom.

DESIGN FOR THE ROBOTEACHER MODULE DEVELOPMENT

The research design is based on the WATERFALL Model and also follows all the procedures or phases in this model, which comprise requirements, design, implementation, verification, and maintenance phases.

In the design phase, an application namely Canva is used to produce a design for the module to ensure that the development process goes well. Besides, this application is seen as a helpful tool for the researchers in developing the module due to some factors apart from it being accessible using any type of electronic device. Next, it also offers interesting and user-friendly features such as automatically saving all edited data, which lessens the hassle of use, especially for beginners. Another tool utilised by the researchers is AutoDesk Fusion 360 software, which helps design the practical activities to fulfil the requirements of 21st-century learning activities. This software is convenient to use and has more similarities to AutoCAD than Solid Work. Hence, the researchers opted for this software instead.

Additional technological components like a touch sensor, Bluetooth 129 receiver or controller for the Lego Robot surely increase the complexity but the module's usability and application are able to be widened, which consequently attracts the students' interest in more interactive experiments. Apart from that, the captivating and cheerful colours employed in this module play a pivotal role in making the concepts clearer as well as enhancing the students' visual experiences. As a result, students get to comprehend the lessons better and experience an interactive learning environment. An effective teaching aid is believed to be produced if all these aforementioned elements are combined while developing the RoboTeacher Module as it is able to strengthen knowledge and technological skills among the Form 2 and Form 3 students, specifically in the Robotics and Technology context.

FIGURE 2.

VALIDITY EVALUATION ON THE DEVELOPMENT OF THE ROBOTEACHER MODULE

Overall, all the respondents agreed that this module works effectively and is safe to be utilised in the learning context of the microcontroller from Lego. However, a respondent viewed this module as a medium for students' comprehension enhancement meanwhile the rest of the respondents' views require further evaluation to identify the actual impacts of the module on learning achievement. Despite having differences in terms of respondents' views, this module is believed to fulfil most of the criteria identified in this research.

In general, the utilisation of the Lego Robot is an effective approach to applying the Science, Technology, Engineering and Mathematics (STEM) elements in the teaching process as it not only allows students to comprehend the elements but also to apply them accordingly. This is said because there are complete STEM elements in this robot. For instance, technological elements can be seen through the use of tools like coding software while engineering elements comprise all aspects of the components such as the gear system that plays a role in moving the robot. Furthermore, Mathematics elements are also applied while planning for the use of components accurately to ensure that the robot can be produced perfectly.

It is recommended to improve the teacher's version by including more elements like collaboration, critical thinking, creativity and communication to ensure that this module remains relevant to 21st-century learning demands. Teachers are also required to play their roles by being actively involved in facilitating student-centred learning, encouraging cooperative learning among students and initiating problem-solving learning through project-oriented activities. Another suggestion for improvement is to prepare additional guidelines for reading the coordination on the IO Expansion Shield.

CONCLUSION

In summary, the RoboTeacher Module is one of the teaching aids that can be used in a Learning and Facilitation session or *sesi Pembelajaran dan Pemudahcara (PdPc)* for Form 3 students in the Design and Technology subject or *Reka Bentuk dan Teknologi (RBT)* specifically on the Mechatronic Design topic. This RoboTeacher Module is certainly able to leave positive impacts on students' learning as it allows them to also gain technological knowledge while handling the Lego Robot. Students need to get adequate exposure to technologically conceptualised learning to broaden the robotics application, which subsequently enhances their interest in more interactive experiments. The Roboteacher Module development should be suitable to cater to students' different mastery levels and ages to prevent it from being a burden for them in learning new concepts. Therefore, this research is envisioned to assist both teachers and students in the Technical and Vocational (FTV) field, especially in giving clearer exposure as well as responding to all questions that arise regarding the utilisation of the RoboTeacher Module in the PdPc session for the Form 3 Mechatronic Design topic. In addition, teachers also play pivotal roles in assisting students to apply the RoboTeacher Module effectively. This is said to ensure that students' can successfully receive and comprehend the knowledge distributed through printed materials or real objects.

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