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**THE EFFECTIVENESS OF MULTI-ELECTRONIC-  
MAGNETDUINO MODULE WITH AUGMENTED  
REALITY APPLICATION IN ELECTRONIC  
DESIGN TOPIC TOWARDS ACADEMIC  
ACHIEVEMENT AMONG SECONDARY  
SCHOOL STUDENTS**



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**MOHD HAMIZAN BIN JAFINI**

**SULTAN IDRIS EDUCATION UNIVERSITY**

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**DISSERTATION PRESENTED TO QUALIFY FOR A MASTER'S IN MASTER  
OF SCIENCE (TECHNICAL AND VOCATIONAL EDUCATION)  
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**FACULTY OF TECHNICAL AND VOCATIONAL  
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22 OCTOBER 2025

Date

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## ABSTRACT

Design and Technology (RBT) is one of the newest subjects which is given to Living Skills's (KHB's) teachers as a priority to teach the students. However, the teachers are less skills in pedagogical content to teach students in creative ways and lack of contents in electronic design topic. The development of module has not yet to discover the visualisation effect of students in electronic design topic. This study was aimed to develop and evaluate the effectiveness of Multi-Electronic-MagnetDuino module with Augmented Reality (AR) application in electronic design topic towards academic achievement among secondary school students. The development of the module is based on ADDIE Model with quantitative research design approach. The semi-structured interview is conducted with 5 experts to find the needs of electronic design during analysis phase. The module was designed in design phase where the module and application were designed based on need analysis and theories such as Cognitivism, Behaviourism, Multisensory Learning, Cognitive Theory of Multimedia Learning, and Flipped Classroom. The validation process is conducted in development phase where the module and test instrument were validated by 9 experts while the application was validated by 3 experts. The data were analysed by Content Validity Index (CVI) approach. The pilot study is conducted during implementation phase with 30 sample of students which shows 0.709 reliability value for test instrument. This shows that the test instrument can be used in evaluation phase due to its consistency. A Quas-experimental approaches were used in the study with 54 form two RBT students from one of the schools in Batang Padang district. The samples were divided into 26 students for control group and 28 students for experimental group. Three research instruments were employed which are Multi-Electronic-MagnetDuino Module, Multi-Electronic-MagnetDuino application, and test instrument. The data were analysed to explain the differences of students' mean academic achievement between control and experimental group. The findings showed that there was an improvement of students' mean academic achievement for both control group ( $M=10.50$ ) and experimental group ( $M=13.57$ ) which shows there is significant differences of students' mean academic achievement ( $p<0.001$ ) through t-test analysis where the normality data of students' academic achievement is approximately between  $-1.96$  and  $+1.96$ . As a conclusion, the Multi-Electronic-MagnetDuino Module can improve students' academic achievement better and drastically. This would also help students to increase their visualization effect and understanding in electronic design topic. The teachers would have multiple of teaching methods which would help them to avoid students from boresome. Therefore, the module is important to both students and teachers that could be useful for the Ministry of Education to use them in the future for other purposes.





## **KEBERKESANAN MODUL MULTI-ELEKTRONIK-MAGNETDUINO DENGAN APLIKASI REALITI TERIMBUH DALAM TOPIK REKA BENTUK ELEKTRONIK TERHADAP PENCAPAIAN AKADEMIK DALAM KALANGAN MURID SEKOLAH MENENGAH**

### **ABSTRAK**

Reka Bentuk dan Teknologi (RBT) merupakan salah satu mata pelajaran yang baharu yang diberikan keutamaan kepada guru Kemahiran Hidup Bersepadu (KHB) untuk mengajar murid. Namun begitu, terdapat sebilangan guru kurang menguasai kandungan pedagogi untuk mengajar murid dengan kreatif serta kurang pengetahuan dalam topik reka bentuk elektronik. Pembangunan modul juga masih belum meneroka kesan visualisasi terhadap murid dalam topik reka bentuk elektronik daripada kajian lepas. Kajian ini dijalankan bertujuan untuk membangun dan menilai keberkesanan modul Multi-Elektronik-MagnetDuino dengan aplikasi realiti terimbuhan dalam topik reka bentuk elektronik terhadap pencapaian akademik dalam kalangan murid sekolah menengah. Pembangunan modul ini berasaskan Model ADDIE dengan pendekatan kajian kuantitatif. Temu bual separa berstruktur dijalankan bersama 5 orang pakar bagi mengenal pasti keperluan dalam topik reka bentuk elektronik semasa fasa analisis. Modul direka bentuk dalam fasa reka bentuk iaitu modul dan aplikasi dibangunkan berdasarkan analisis dan teori seperti Kognitif, Behaviorisme, Pembelajaran Multisensori, Teori Kognitif Pembelajaran Multimedia, dan *Flipped Classroom*. Proses kesahan dijalankan dalam fasa pembangunan iaitu modul dan ujian disahkan oleh 9 orang pakar, manakala aplikasi disahkan oleh 3 orang pakar. Data dianalisis menggunakan pendekatan Indeks Kesahan Kandungan (CVI). Kajian rintis dijalankan dalam fasa pelaksanaan dengan 30 sampel murid, dan telah menunjukkan nilai kebolehpercayaan ujian ialah 0.709, menandakan bahawa ujian boleh digunakan dalam fasa penilaian kerana mempunyai konsistensi yang baik. Pendekatan kuasi-eksperimen digunakan dalam kajian ini melibatkan 54 sampel murid Tingkatan Dua RBT dari sebuah sekolah di daerah Batang Padang. Sampel dibahagikan kepada 26 sampel murid kumpulan kawalan dan 28 sampel murid kumpulan eksperimen. Tiga instrumen kajian digunakan iaitu modul Multi-Elektronik-MagnetDuino, Aplikasi Multi-Elektronik-MagnetDuino, dan ujian. Data dianalisis bagi menjelaskan perbezaan min pencapaian akademik antara kumpulan kawalan dan kumpulan eksperimen. Dapatan kajian menunjukkan terdapat peningkatan min pencapaian akademik murid bagi kedua-dua kumpulan iaitu kumpulan kawalan ( $M=10.50$ ) dan kumpulan eksperimen ( $M=13.57$ ) yang menunjukkan terdapat perbezaan yang signifikan dalam min pencapaian akademik murid ( $p<0.001$ ) berdasarkan analisis ujian-t, dengan data normaliti pencapaian murid berada di antara -1.96 hingga +1.96. Kesimpulannya, modul Multi-





Elektronik-MagnetDuino dapat meningkatkan akademik murid dengan lebih baik dan ketara. Murid dapat meningkatkan kesan visualisasi serta kefahaman mereka dalam topik reka bentuk elektronik. Guru pula akan mempunyai kaedah pengajaran yang dapat mengelakkan murid daripada bosan. Oleh itu, modul ini penting untuk kedua-dua pihak serta berpotensi until digunakan oleh Kementerian Pendidikan pada masa akan datang.



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## LIST OF ABBREVIATION

2D	2 Dimensional
3D	3 Dimensional
ADDIE	Analysis, Design, Development, Implementation, Evaluation
APA	American Psychological Association
AR	Augmented Reality
ASK	Computer Science
COVID-19	Coronavirus Disease 2019
CPU	Central Processor Unit
DSKP	Curriculum Standard and Assessment Documentation
IoT	Internet of Things
IR 4.0	Fourth Industry Revolution
KHB	Living Skills
KSSM	Secondary School Curriculum Standard
MOE	Ministry of Education
MOHE	Ministry of Higher Education
MOHR	Ministry of Human Resources
RBT	Design and Technology
S	Strategy
SDG	Sustainable Development Goals
STEM	Science, Technology, Engineering, and Mathematics
T	Thrust
TP	Mastery Level



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TS25	School Transformation Programme 2025
TVET	Technical and Vocational Education Training
VAKT	Visual, Auditory, Kinesthetic, and Tactile
T&L	Teaching and Learning
CVI	Content Validity Index



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## CHAPTER 1

### INTRODUCTION



Education is one of the most important aspects which people needed in their life based on their daily needs. After pandemic of COVID-19, there are most of the students lack of skills and values due to online learning. According to Lestari and Gunawan (2020), they find it hard for the students to learn online due to low internet connection from some places such as Pahang, Kelantan, Sabah, and Sarawak (Ating, 2020). According to Hanemann (2019), the fourth SDGs aims to ensure successful completion of basic study which leads an effective and relevant ways of learning outcomes of children, youth, and adults, as improving their lifelong learning engagement for developing a harmonized, and inclusive approach of education in Malaysia.

Technical and Vocational Education Training (TVET) aims to develop skilled and intelligent youth to become better at understanding methods, concepts, and





processes in industry. According to Yaakob et al. (2020), there are ministries provide TVET education in Malaysia theoretically and practically such as Ministry of Education (MOE), Ministry of Human Resource and Development, Ministry of Community Development and other sectors or agencies. The TVET education provides semi-skilled workforce that can enhance global market (Abdullah et al., 2020) such as baking, fishing, farming, sewing, manufacturing, designing, and others to improve their skills and create graduates with knowledge to work in global market.

Integration of technologies are applied in education nowadays which is convenient for students and teachers to use such as 2D simulation and Augmented Reality (AR) that leads to enable industry revolution 4.0 concepts (Masood and Egger, 2019; Rymarczyk, 2020). Implementation of AR in class can attracts students' attention in class (Nechypurenko et al., 2020) which provides visualization of students to understand deeply theoretically (Sari et al., 2021). The visualization effect of students which application of AR during Teaching and Learning (T&L) sessions help both students and teachers to improves the quality of T&L in class.

Design and Technology (RBT) is one of the newest subjects for TVET education in primary and secondary schools. RBT subject is introduced to attract youth into TVET education which involves problem-solving and critical thinking to create new products. There are several topics in RBT which enhances students' basic knowledge and skills such as manufacturing, mechanical, electrical, electronic, aquaponic, food design and other. Although this subject can enhance students' skills and knowledge, there are several challenges encountered among students and teachers in RBT subject especially in electronic topic (Ajit et al., 2022).





## 1.2 Background Research

RBT subject is one of the newest subjects which is given to KHB's teacher as a priority to teach the students. Unexpectedly, the COVID-19 is one of the biggest issues which makes the teachers to teach and educate the students after implementing RBT subject withing three years. According to Tarkar (2020), the impact of COVID-19 in education among children had given a negative impact for students such as enhancing their skill growth in social awareness and social skills. The teachers had to avoid any physical contact from students which made them difficult to teach. The online learning is introduced in education system to educate students with knowledge. Although, this situation can be prevented by online learning but there were some residential areas had low internet access (Sufian et al., 2020) such as Pahang, Kelantan, Sabah, and Sarawak (Ating, 2020). This situation made the students hard to gain their knowledge due to low internet access. Students needed to achieve their highest cognitive level to develop new products but the teachers only can observe virtually which was unacceptable. According to Pokhrel and Chhetri (2021) had discussed that pedagogy which needed to be learned physically or face-to-face learning is not feasible for online learning.

After declaration the end of COVID-19, there were some challenges and issues in education among students and teachers. Students nowadays are addicted with online games which require gadgets such as smartphone, computer, and laptop. Musa et al. (2021) explained that the children nowadays prefer online and offline games rather than traditional games which excite them to play in modern world. According to Halim et al. (2020), students were motivated during T&L session when implementing games such as online quizzes. As a result, Leverage ICT to Scale up Quality Learning Across Malaysia (Shift 7) were introduced to enhance the quality of use in ICT or technologies.





The teachers and students prefer in-school training with the availability of technologies in classroom (Winter et al., 2021) which would enhance teachers and students use of technologies during T&L sessions. Although, technologies can enhance during T&L sessions but about 56% of teachers could not use TV monitors, computers, and interactive whiteboard during T&L sessions (Winter et al., 2021). These studies showed that there is no existing study in electronic topic under RBT subject which implemented technologies during T&L sessions.

There are previous studies and research had proven that T&L aids are needed in RBT especially for electronic topic. There were about 1.97 until 2.21 mean value of teachers have not yet to master application topic especially in electronic topic of RBT subject (Sahaat and Nasri, 2020). According to Masingan and Sharif (2019), the teachers are also lack of knowledge to teach students in creative ways in RBT subject. The new curriculum of RBT makes them hard to understand during T&L session due to their knowledge in RBT subjects. Based on Arshad et al. (2023) findings, the trainings provided for teachers in electronic are less efficient which makes them hard to understand in electronic topic. Other than that, Sahaat and Nasri (2020) had proven that the duration of time to teach student in electronic topic is still low. This statement had been supported by Yong (2019) which electronic topic in RBT subject has less T&L aids which could triggered students' academic achievement. These studies showed that there is no existing study which had solve the challenges in electronic topic.

Students are having problems on understanding practically and theoretically in electronic topic. Ajit et al. (2022) found out that students could not reach their mastery level in taxonomy bloom in application technology topics such as electronic design





topic due to poor thinking skills and problem-solving. This would affect students' visualization skill which the students could not imagine the design of electronic product at the end of T&L sessions. The visualization skill is important for the students to master as it effects the students' academic achievement (Ajit et al., 2022). There is a study from Othman (2024) discovered that students were having difficulty on understanding electronic components, following programming aspects, and distinguishing electronic components to build circuit connection by using microcontroller. These three aspects showed that the students' visualization skill is important for them to master in electronic topic. This statement had been supported by Liono et al. (2021) which the students cannot visualize the process of interconnection between electronic components and microcontroller in simulation software. The same study found out from Ting et al. (2024) where the students cannot make a proper connection between electronic components which make them less motivated to learn about electronic topic. These statements shows that the students still lack exposure to develop and design a product by using electronic components (Padzil et al., 2022). A study from Aizuddin et al. (2024) had discovered that students are lack of technical knowledge in electronic topic. These studies showed that there is no existing study of visualization skill in secondary school.

According to Ramli et al. (2023), the students still lack memorisation skill which they cannot remember the contents of electrical and electronic contents. This study is supported by Ramlee et al. (2024) where the students found it difficult to imagine the system in electronic circuit. Students still could not remember the function of each component in electronic due to cognitive loads. A study from Azman and Rahman (2022) had also discovered that students are having difficulty on using NI Multisim because they are no guidance to conduct the experiment through simulation.





These studies showed that there is no existing study which guide the students to build electronic circuit properly.

### 1.3 Problem Statement

RBT is one of the subjects which is hard to understand by students and teachers (Sahaat and Nasri, 2020; Ramli et al., 2024). One of the topics which the students hard to understand and the teachers hard to teach is electronic design topic. Electronic design topic needed both knowledge and practical skills to master the topic well. One of the challenges encountered in electronic design topic is less of teaching aids in electronic design topic (Hussain et al., 2024). The teachers also have less knowledge of programming and electronic skills which made them hard to understand the pedagogical content of electronic design topic (Dahari et al., 2024). There are some students tend to forget symbols of electronic design topic which leads the students unable to interconnect between electronic components and microcontroller (Ramli et al., 2023). This is due to students' low ability of visualization effect where they could not imagine the interconnection of electronic components and microcontroller based on their experience (Liono et al, 2021; Ting et al., 2024).

### 1.4 Objective of the Study

The objective of this research is to:

- i. Analyse the needs of development of electronic design module for teachers in secondary school.
- ii. Develop the electronic design module for teachers in secondary school.





- iii. Verify the validity of electronic design module among experts.
- iv. Evaluate the effectiveness of electronic design module towards academic achievement among students in secondary school.

### 1.5 Research Questions

Based on the objective of the study of the research, there are multiple of research questions to reach the objectives of the research accordingly which are:

- a) Analyse the needs of development of electronic design module for teachers in secondary school.
  - i. What are the needs of development of electronic design module for teachers in secondary school?
- b) Develop the electronic design module for teachers in secondary school.
  - i. How to develop electronic design module based on ADDIE Model for teachers in secondary school?
- c) Verify the validity of electronic design module among experts.
  - i. What is the level of validity in electronic design module among experts?
- d) Evaluate the effectiveness of electronic design module towards academic achievement among students in secondary school.
  - i. What is the effectiveness of electronic design module towards academic achievement among students in secondary school?





## 1.6 Research Hypothesis

Based on the fourth research objective of this study, the research hypothesis that need to be tested are:

H<sub>0</sub>1: There is no significant difference in students' mean pre-test academic achievement between the control and experimental groups.

H<sub>0</sub>2: There is no significant difference in students' mean pre-test and post-test academic achievement in control group.

H<sub>0</sub>3: There is no significant difference in students' mean pre-test and post-test academic achievement in experimental group.

H<sub>0</sub>4: There is no significant difference in students' mean post-test academic achievement between the control and experimental groups.



## 1.7 Conceptual Framework of Research

Conceptual framework is the idea on how to develop the high quality of ideas, structures, plans, and discipline in implementation overall research (Kivunja, 2018).

Conceptual framework can make a person more organised due to the flow of its research more stable and trustworthy based on the theory and article that have been read. Ali (2019) elaborates conceptual framework also can see the relationship between research variables and its theory, model and phenomena that have been picked up. This can lead to a better understanding of research due to the presence of relationships between each variable.





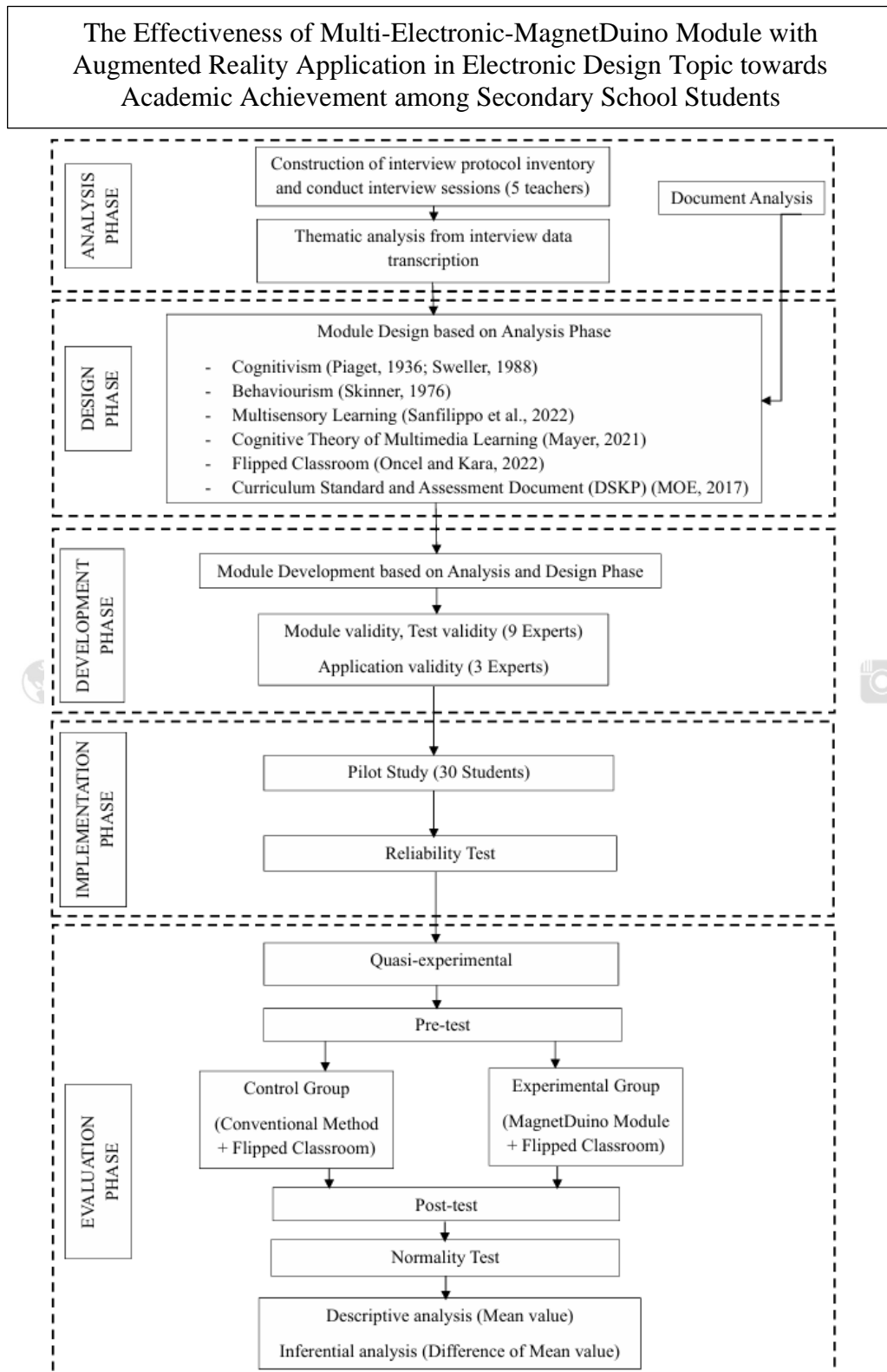
This research implements two types of variables which are independent variable and dependent variable. Independent variable in this research is “Multi-Electronic-MagnetDuino” module for teachers and students in school. The module concludes various types of educational theory and the need of each element in the module. This module is built or created by using an instructional design model which is Analysis, Design, Development, Implementation, Evaluation Model (ADDIE Model). Dependent variable in this research can be referred to as the effect of academic achievement evaluation in students after implementing the module. The conceptual framework, derived from a review of relevant literature review, incorporates core ideas, key concepts from theories, significant findings from research, policy statements, and experts’ knowledge, thereby guiding the research project by organising and defining its focus and direction (Shikalepo, 2020). The conceptual framework research is shown in

Figure 1.1.



**Figure 1.1**

*Conceptual Framework Research*





## 1.8 Operational Definition

This research consists of some terms with definitions for each terminology used to convey better understanding and purpose of the words. These are the used terms with definitions in the research:

### 1.8.1 Module Development

Development in terms of education can be defined as a process to design a specific knowledge or information to physical structure. Cambridge Dictionary (2021) explained development is the process of coming into existence or of creating something new or more advanced. This statement proves development is the key to education which could leads a better understanding in education and knowledge in the future.

Understanding the development of module will enhance the T&L process more effective due to systematic development of contents in a module. According to Shaifuddin and Nashir (2022), T&L of a subject can be effective and efficient as it is improving students' knowledge when one knows to produce a module systematically in education for students and teachers.

A learning module is an independent, formalised learning experience with a consistent and clear set of understanding outcomes and assessment criteria (Rufii, 2015). Dewi and Primayana (2019) stated that learning modules, whether printed or digital, are comprehensive units that support learning activities to assist students achieving multiple objectives or skills, enhancing their knowledge, and understanding as the course progresses, and serving as a valuable teaching aid to foster students' higher order thinking skills (HOTS). According to Mufidah (2014), a module is





structured instructional material for an individual study that delivers topics in a way that makes it easy for the reader to comprehend and apply the lessons. Instructional materials are tools or resources used by educators to support and facilitate the T&L process (Olayinka, 2016; Dhakal, 2017; Choppin et al., 2022) and help students achieve the stated objectives (Nwike and Catherine, 2013). In addition, the used of learning media in the form of learning modules may also improve student motivation as well as promoted independent learning (Rufii, 2015; Vallespin, 2021).

In this research the module development is a process of building instructional material to be used in class with strategic learning theories and model. The module is one of the materials which can guide teachers to teach student which is to support learning activities and assist students and teachers during teaching and learning session. The development of the module can enhance their knowledge to reach objectives of DSKP and understanding the concept of electronic design. Nonetheless, module development as teaching aids can also increase their score in academic and motivation which helps them to improve their knowledge and quality of understanding in electronic design topic.

### **1.8.2 Microcontroller**

Microcontroller an electronic device which contains all components that allow it to operate alone, and it has been designed for monitoring and/or control tasks (Gridling and Weiss, 2007). This electronic device is different from microprocessor which allows to work on one board instead of multiple boards.

People nowadays tend to depend on technology because it saves a lot of money and time which makes it easier to do other things. University students learn





microcontroller and coding to survive in engineering industry and real life. Bolanakis (2019) elaborates four factors of microcontroller research methods in 1998 until 2007 which are for teaching strategies, distance education, teaching tools and share/promote practices but an increasingly high of research methods of microcontrollers in 2013 until 2018 due to the presence of advance technology. This shows that technology is majorly needed by people nowadays to manageable to a better life and future.

In this research, the researcher read the concept of microcontroller in order to align the curriculum standard in DSKP and RBT Form 2 Textbook needs. There are two types of microcontrollers will be used as a content in the module which are Magnetcode and Arduino. The Magnetcode microcontroller is used as a content in the module due to its availability in RBT Form 2 Textbook (main reference) while the Arduino microcontroller is uses as a content in the module due to its low cost and structure which almost acts the same function as Magnetcode.

### **1.8.3 Design and Technology (RBT) Subject**

Design and Technology (RBT) is being introduced by Ministry of Education to replace KHB from TVET subject in primary and secondary schools. DSKP of RBT subject is being described as a subject which a concept or a fundamental of technology that students need to learn for them to produce or build a new product with critical thinking skills (MOE, 2017). Masingan and Sharif (2019) describes RBT subject is a practical subject which emphasize the integration of technology in learning and teaching to develop students' potential in a way of comprehensive, balanced and integrated. There are several topics in RBT which need to be mastered by students for them to create, build or develop a new product by on the topic students have learned. The educators or





teachers need to teach the students based on DSKP which is developed by MOE for them to understand what students need to achieve at the end of T&L lessons.

In this research, RBT is one of the newest subjects which have not yet to learn by students before 2017. The implementation of microcontroller in RBT is one of the newest contents which integrate electronic, microcontroller and programming. Most of the contents in KHB are not the same as RBT. The content of RBT is mostly about building a project or product with the use of electronic knowledge, microcontroller, and programming while the content of KHB is mostly about building electronic modules through skills and knowledge of electronic such as soldering. Therefore, the researcher makes an initiative to do research about electronic, and microcontroller knowledge among RBT students in secondary school.



In e-learning, a simulation is a tool that creates animation of environment to teach something specific. I usually show different scenarios based on the changes made by the user. The simulation might include animations, audio or video clips, role-playing and web graphics. It can also expand on a case study. One of the benefits of simulation in education is that they let students to experiment with data and see the results in a safe space or setting, or in situations they would not usually have access (Rennie and Smyth, 2019).

A 2D simulation refers to the use of computer-generated models to replicate and analyse the behaviour of systems or processes within a two-dimensional plane. This operational definition involves creating simplified representations of real-world phenomena where only two spatial dimensions—length and width—are considered. 2D





simulations are widely used in various fields such as physics, engineering, economics, and education to study complex systems through visualization and experimentation in a controlled, virtual environment. According to Wu and Huang (2020), 2D simulations are particularly useful for scenarios where the third dimension (depth) can be ignored without significantly impacting the accuracy or relevance of the results, allowing for easier computation and interpretation of data.

From a functional standpoint, 2D simulations must include accurate mathematical modelling, real-time data processing, and visual rendering to be considered operational. These simulations often utilize algorithms to calculate outcomes based on initial conditions and variables set by the user, making them essential tools for predictive analysis and decision-making. For example, in fluid dynamics, 2D simulations can model the flow of liquids and gases across surfaces, providing insights into behaviours such as turbulence and pressure distribution (Li et al., 2021). The operational criteria for 2D simulations emphasize simplicity and efficiency, making them ideal for educational purposes, where they can visually demonstrate concepts and theories in an accessible manner.

In this research, 2D simulation is used to simulate the electronic project or build by using microcontroller. The researcher uses one application and one software which are Magnetcode and Thinkercad respectively. These can be used during T&L session which replaced the use of electronic components and microcontroller. The students can stimulate the project through the application and software to understand knowledge the function of microcontroller through 2D.





### 1.8.5 Augmented Reality

Augmented Reality (AR) specifies the technology as a system that enhances real-world environments by overlaying digital content, such as images, sounds, or other sensory inputs, through devices like smartphones, tablets, or AR glasses. AR operates by utilizing a combination of hardware and software components that include sensors, cameras, and processors to detect and interpret the physical environment.

According to Milgram and Kishino (1994), AR exists on a continuum of mixed reality, where real and virtual environments are combined in various degrees, with AR being closer to the real-world end of this spectrum. This imaging technique add digital information on top of the real world in real-time to create an improved environment. For an example, it might add digital labels to identify parts during mechanical or medical procedures. Azuma (1997) emphasizes that for AR to be effective, it must not only blend virtual and real content but also ensure that the virtual elements are contextually appropriate and responsive to the user's movements and actions. Unlike virtual reality, which creates completely artificial environments, this technique combines real and digital information (Rennie and Smyth, 2019). As defined by Carmigniani and Furht (2019), AR must enable users to interact naturally with the augmented elements as if they were part of their immediate environment.

Billingham et al. (2015), AR systems are now expected to provide not only visual augmentation but also multimodal interactions that involve haptic feedback, spatial audio, and gesture-based controls. This expanded operational definition emphasizes the importance of creating a fluid and interactive user experience that goes beyond visual augmentation. Moreover, with advancements in AI and machine





learning, AR applications have become more sophisticated, allowing for dynamic content adaptation based on user behaviour and environmental changes, which has broadened its applicability across industries such as healthcare, education, and entertainment (Chen et al., 2022).

In this research, the researcher uses AR by using application and 3D model which was developed. The AR is implemented in the research among students to see the 3D model in reality. The AR is implemented into T&L session to enhance the visualisation effect of students. This visualization effect can be interacted by user through phone rotation to see the detail information of interconnection between electronic components and microcontroller. This leads to change behaviour of students which makes them to build the project in reality.



## 1.9 Research Scope and Limitations

These are the research scope in the study during the research which are:

- i. This research is conducted in one school of Perak (School A).
- ii. The analysis phase or research making is conducted by using semi-structured interview and document analysis with five experience RBT teachers.
- iii. The face and content validity of module and test instruments are validated by nine experts who are in RBT field and UASA examination drafters.
- iv. The application design validity is validated by three experts who are in computer science and information technology experts.
- v. The test instrument reliability is conducted during pilot study with 30 samples of RBT students in school A from Group X.





- vi. The effectiveness of the module is conducted by using quasi-experimental method with purposive sampling method from school A. The control group is conducted from Group Y and Group Z.

There are some limitations in the research. The sampling method which is used by researcher is purposive sampling method where the research of the study only involved one school. The researcher could not use the whole school which involves high number of students to determine the effectiveness of the module. The usability of the module had not yet to be discovered by the researcher which the researcher only study about the effectiveness of the module. The module is valid to be used during the study but some researcher such as (Noah and Ahmad, 2005) which discover reliability of the module had not yet to be discovered by the researcher. This is due to the sample of teachers to test the module reliability is not enough and it would take long period of time for teachers and students to answer the questionnaires which triggers their daily lesson plan during teaching and learning session.

### **1.10 Importance of Research**

This research is about the development of module as a T&L aid for students to understand the knowledge and every concept of electronic design. There are diverse kinds of research which is specific in RBT and most of the research is about the need of analysis of every topic in RBT. There were no existence or validity of research which conduct the development of module for electronic in electronic design especially for form 2 students. This research is being held to distinguish the impact or effect of a module towards students in secondary school from their understanding and knowledge





in electronic design topic. Hence, the findings and importance of the study can be used as a guide to:

### 1.10.1 Design and Technology (RBT) Students

The development of “Multi-Electronic-MagnetDuino” Module is being developed as a reference and exercise to guide the students understand about electronic and well as microcontrollers. Various kinds of learning methods the students could in “Multi-Electronic-MagnetDuino” Module which contains multimedia such as online quizzes, videos, experiment of microcontrollers and games. Abdulrahaman et al. (2020) stated that multimedia can enhance to improve T&L as it assists the learners with mental representations well to use different platforms of multimedia elements. This platform of module will indirectly increase students’ academic achievement and motivation well.



This module can be used by students and teachers during T&L sessions. Aprilia and Suryadarma (2020) have found out that module can be feasible and effective to use in T&L session or self-regulated learning. The platform for this module can also be convenient for the students to use and access anywhere. One of the main objectives of developing this module is to help students understand and master the microcontroller and electronic design concept, thus improving their learning outcomes. It is a teaching aid that supports and facilitate the T&L process. This module will facilitate students with their independent learning time (Rufii, 2015), Regardless of the place and time of study, to further increase their knowledge and understanding. This module also contains the practical worksheet for the practical session, allowing students to prepare in advance for the practical session.





### 1.10.2 Design and Technology (RBT) Teachers

Teachers can also use “Multi-Electronic-MagnetDuino” Module as T&L aids during teaching lessons. Teachers can teach various kinds of teaching methods when they use this module. Flipped classroom is a common thing that can be used for teaching methods. Dewi and Primayana (2019) explained that the learning module with teaching and method contextual can increase the knowledge of every concept in the module. This statement shows that a positive impact can be achieved by teachers if the module is being applied during T&L lessons among students with direct learning models.

This module platform can also be convenient for the teachers to use due to various kind of resources which the module has such as online quizzes, notes, experiment, games, and videos. This module platform gives a positive impact towards teachers to save some time during T&L lessons. Traditionally, the role of a teacher in the classroom is to deliver knowledge based on curriculum designed to meet the set guidelines and rules, but the scenario had changed to some extent, and teachers now act to facilitate lessons and the management of learning environments and activities (Green, 2020; Sabri and Abdul, 2020). Maksum and Purwanto (2022) suggested that teachers should teach by using created modules and workshop manuals with the students to improve the learning process. Thus, using the “Multi-Electronic-MagnetDuino” module as a teaching aid during a T&L session will help facilitate the lesson while promoting active and independent learning.

### 1.10.3 Ministry of Education (MOE)

Development of this module meet the needs of technology T&L nowadays. It involves students critical thinking and self-regulated learning to use microcontrollers





appropriately. Module platform can be considered as one of the technologies which enhance the method of T&L methods. This module does meet School Transformation Programme 2025 (TS25) which teachers apply the best concept in T&L methods, teachers develop from internal expertise through comprehensive and structured training to pedagogy advisor leadership and develop effective T&L method by prioritizing student development during lesson.

### 1.11 Summary

RBT is one of the subjects which is hard to understand and teach by students and teachers due to the existences of several challenges. These challenges can be encountered by using technologies such as simulation and AR. Therefore, there are four main objectives which were to analyse needs from experts, develop and verify the module from experts, and evaluate the effectiveness of the module which align with research questions, research hypothesis, and conceptual framework. This chapter also contains operational definitions, research scope and limitations, and importance of research which help to understand the terms, full view, and future impact of the research.

