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The Attitudes of Secondary School Teachers toward the Utilization of Microcontroller in The Classroom

Azlina Muhammad Noor & Jamalsafri Saibon
Universiti Sains Malaysia

Abstract
The goal of this study was to determine the level of smart electronic device microcontroller development boards were used as teaching tools (BBM) in Penang secondary schools for the teaching and learning of the subject of design and technology (RBT). The effectiveness of using microcontroller development boards as instructional aids and tools (BBM) based on digital technology might enhance the quality of instruction and learning in electronic design provided by RBT teachers. As a result, this article describes the conclusions of the attitudes of RBT teachers towards fuel usage that were based on a microcontroller development board. To conduct the study, 128 RBT teachers who teach electronic design to Form 2 and Form 3 students in secondary schools were given questionnaires. Statistical Package for the Social Sciences (SPSS) Version 26 software was used to perform a descriptive analysis of the data to determine the frequency distribution, percentage, and mean comparison. T-tests were also run to determine whether there was a gender difference. With an average score of 3.93, the results demonstrate that Form 2 and Form 3 RBT teachers had a moderate attitude regarding the employment of microcontroller boards. The t-test results, however, revealed no gender differences between the RBT teachers' use of the microcontroller board. The same research topics were recommended to be broadened to include students in the future and explore the relationship between teachers' attitudes and the use of microcontrollers from a behavioral perspective in Malaysian classrooms.
Keyword: Microcontroller, Attitude, Design and Technology (RBT) Teachers, Teaching Tools and Aids

Introduction

The social, political, economic, and educational demands of the shifting global landscape are being impacted by the Industrial Revolution 4.0 challenge of employing the Internet and widely used automated robots globally (Schwab, 2016; Prisecaru, 2016; Anne Marie, 2018). Since virtually every piece of equipment in the sector uses automation in the manufacturing process, a Microcontroller is primarily employed to ensure that robotic automation electronic processes run smoothly. The input and output processes of an electronic hardware device can be appropriately managed, organised, and monitored automatically by a microcontroller (Nethravathi & Geetha, 2016). It is referred to be an advanced smart device control system that offers numerous advantages in industrial and hardware design electronics to address various issues that arise in daily life (Mallik & Rajguru, 2018; Barak, 2013). Microcontrollers are classified as part of digital electronics and are abstract in nature. They contain hardware and software learning outcomes, including analogue electronic circuits, digital circuits, computer theory, programming languages, a variety of sensors, and circuits (Barak, 2013). According to previous studies, these learning outcomes are still relatively challenging because they demand a high level of theoretical knowledge and skills, logical thinking, and high levels of hands-on control, such as FPGAs (Field Programmable Gate Array) (El-Abd, 2017; Qin & Yu, 2011). As a control system for smart electronics, microcontrollers are a technology that is growing progressively more common in daily life. It has attracted attention due to its potential to significantly advance programming, STEM education robotics, Industrial Revolution 4.0 (IR 4.0), and other industrial and manufacturing fields (Bruce et al., 2013; Lu, 2017; Minister of Education (MOE), 2016; Nugent et al., 2019).

There was a flurry of activity in the publication of academic journal papers devoted to microcontrollers from 1998 till 2017. Researchers have found that microcontrollers are widely utilized in classrooms around the world as a means of instructing students in areas such as programming, making, and simulated learning activities (Bolanakis, 2019).

Ibrahim et al (2015), stated in their study, with the advancement of electrical and electronic engineering worldwide, there are now an alternative to teach students how to use microcontrollers. Thus, the Malaysian higher education system emphasizes the teaching of microcontrollers in embedded systems instruction for aspiring electronic design engineers (Ibrahim et al., 2015). In addition to the current technological advances that can assist students in developing a more logical computational mindset, microcontroller programming is an increasingly important skill to learn for any vocational educator (Santosa & Waluyanti, 2019). Since, there is a need for microcontroller knowledge among non-engineers and beginners, various development board designs have appeared in the market influenced by the competitive price of the market (Cruz, 2017). In addition, various age groups are attracted by the advantages of their DIY features and open-source development board designs from companies such as Sparkfun, Adafruit, arduino, and microbids (Bolnakis, 2019; Lima et al., 2018; Vostrukhin & Vakhtina, 2016; Mabbott, 2014; Barak, 2013). Also, several different types of kits, such as the Thames & Cosmos Microcontroller Computer System Engineering Kit, the PICDEM Lab Development Kit, the Nerdkits Microcontroller Kit, and the BeagleBone Black Kit, have been designed to help students become experts in the field of microcontrollers (Dymek & Murdy, 2016). As a result, the concept of creative learning emerged as increased use and application of microcontroller technology across all educational sectors (robotics), Science, technology, engineering, and mathematics (STEM) education typically as a method of teaching students how to use hardware and software (Sell, 2012). Moreover, the accessibility of microcontrollers to the study of physics, arithmetic, engineering, design, and control system analysis makes it a key topic for electrical and electronic learning strategies (Garca et al., 2018; Mabbott, 2014; Barak, 2013; Sell, 2012).

Literature Review

In Malaysia, students and teachers who are in robotics clubs or have competed in robotics events have known about the use of microcontrollers in the education system since middle and elementary schools (Ibrahim et al., 2014). But in 2017, the secondary school curriculum was changed to reflect the growing impact of digital technology and the growing number of people attending global post-IR 4.0 events (Aparicio et al., 2018). The Ministry of Education Malaysia (MOE) has started to make big changes to education and keep making progress in teaching and learning microcontroller. They are taking this step by implementing a new curriculum (KSSM) and adding a new STEM-based subject called Design and Technology (RBT) to replace Integrated Living Skills (KHB) (Ministry of Education, 2016). The main purpose of introduced Design and Technology (RBT) subject is to provide a teaching tools as microcontrollers are a smart digital technology that is becoming a new trend to help students in Forms 2 and 3 learn how to solve engineering problems by coming up with smart electronic designs for their practical projects (Bunyamin, 2018).

In teaching RBT, typical microcontroller used to demonstrate practical knowledge and technical skills to teachers-students include working with project-based learning (PBL) methods like putting together hardware like light-emitting diodes (LEDs), connecting the keyboard, switches, batteries, DC motor, stepper motor, LCD display, and sensors, and writing small programs like assembly language and C Programming as a command can help students develop creative thinking skills and a higher level of global thinking (Chan et al., 2013). By assessing student performance using problem-based projects based on the Form 3 assessment course work (PT3), MOE urgently needs to strengthen students' computational thinking abilities (Ministry of Education, 2016). RBT teachers must be equipped with a high level of teaching methodology and essential technological skills to teach and learn electronic design in the classroom effectively and efficiently with fundamentals of microcontroller learning (Sharaf et al., 2019; Al-Awidi & Aldhafeeri, 2017).

Apart from providing a advantages of implementing the new curriculum, a few issues have arisen as a result of prior research. The reflection of this RBT curriculum and syllabus revision indicates that there are issues with difficulties and tension when learning about these microcontrollers (He et al., 2015). Meanwhile, for non-engineering or inexperienced undergraduates at the tertiary level found the elements of microcontroller learning that were a combination of many disciplines such as computer science, computer engineering, automated control, and electrical engineering have become a critical issue to learning (He et al., 2015; Ibrahim et al., 2015; Cruz, 2017). Furthermore, teachers face challenges related to their knowledge base, training, and courses, inadequate microprocessor teaching time allocated for student projects, a lack of facilities and additional teaching modules, as well as inadequate use of tools and teaching aids in the classroom (Sahaat & Nasri, 2020).

In summary by the findings of Zamri Sahaat and Nurfaradhilla Nasri's (2020) study towards 418 RBT secondary school teachers in Sarawak (mean value = 2.23), the teachers claim that there is a low-level scarcity of microcontroller teaching materials and aids (ABM) for the instruction of electrical design. Although the study's results indicated that teachers used teaching aids (BBM) at a high level (mean value = 3.71), they had only a low level of mastery of the teaching techniques for each RBT application issue, including the use of microcontrollers (mean value = 2.2). Notwithstanding the study's findings, there were limitations in the allocation of teaching time and the implementation of practical work, and the amount of time students spent putting up electronic projects was insufficient (mean value = 2.15) (Sahaat & Nasri, 2020). This was due to the fact that learning how to use microcontrollers through the usage of hardware and software technologies took more time to be allocated for practical study than it did to master its theory (Nethravathi & Geetha, 2016). This demonstrated unequivocally that there were issues with the way RBT education was carried out.

In following that, Ertmer et al (2012) found that teachers' unfavorable attitudes and beliefs, as well as their fear of being intimidated by technology during instruction, had an impact on how difficult it was to apply technology integration. This is due to the critical role that attitude plays in a person's ability to adopt technology (Davis, 1989). According to an earlier finding, 100 robotics teachers can be produced annually across the country because they had a good attitude, were driven and determined to learn how to use a microcontroller board through activities carried out in robotics basic courses, either directly or as massive online open courses (MOOCs) (Filippov et al., 2017). Similarly, students show a favorable attitude towards the use of microcontrollers and the capacity to create a variety of smart electronic hardware with many functionalities into their project for problem-solving in electronic teaching and learning (Mabbott, 2014).

While Fisher (2006) claimed that teachers' attitudes and beliefs, rather than technology, were the driving force behind changing how students used technology, these two crucial elements ultimately led to a rise in technological success. Researchers in the past have found considerable support for the claims that teachers' attitudes and beliefs are major elements influencing the successful integration of new technologies in classroom learning development and the possibility of their benefiting from training (Kluever et al., 1994; Mumtaz, 2000; Blackwell et al., 2013). Whereas if teachers react favourably to technology, they'll work to improve both themselves and the use of technology in the classroom (Zacharia, 2003). Similar to this, studied have shown, if people have a poor attitude, they won't strive to learn how to effectively adapt to using technology because they'll feel discouraged (Harrison & Rainer, 1992). As a result, the importance of attitude as a baseline for determining whether there is rejection or restrictions inside oneself or if there is acceptance or permits an individual to use technology (Zacharia, 2003; Kriek & Stols, 2010).

Nevertheless, Chien et al (2014) found that even though teachers had a positive attitude towards technology, this did not guarantee that they would perform well when using it in the classroom. This is due to the fact that developing attitudes about technology use takes time, which makes it easier to better adapt the technology (Jimoyiannis, 2008). The attitudes of teachers towards the employment of various forms of technology in teaching and learning have been the subject of numerous studies. Nevertheless, no research was done to determine the attitude of teachers on adopting microcontroller technology in the classroom. For instance, a study by Lazar and Irena (2015) on 143 primary and secondary school teachers in Malaysia indicated that teachers were supportive of the use of Internet teaching in the classroom. Similarly, 16 primary school teachers' opinions revealed that they had a favourable attitude towards the usage of multimedia software for life skills (Fadila & Chiew, 2014).

One demographic factor that determines how people's views and technological proficiency is their gender (Cooper, 2006). Since there is no exception to the use of technology in education, the gender participation of the teachers is the most crucial factor to consider (Kutluca & Ekici, 2010). According to the independent t-test analysis' findings, female teachers were more enthusiastic about using mobile learning than male teachers (M-learning). Uzunboylu and Ozdamli's (2011) research revealed the contrary, with men teachers outpacing female teachers in their positive attitudes towards the usage of such technology.

There was no discernible gender difference in the attitude towards using technology among Malaysian history teachers who used informational tools based on information technology (Jayalatchumy, 2006). The results of other studies, however, indicated that teachers had a favorable attitude towards instructing electrical design (mean value = 4.53) and that there was no significant difference ($p = 0.491$) between the attitudes of male and female teachers towards the field of electricity or that both sexes shared the same favorable attitude (Akmal, 2017). It is necessary to investigate how RBT teachers perceive the use of microcontroller technology in teaching and learning electronic design at the secondary school level in order to determine whether this issue was also influenced by their attitudes. Thus, based on the above arguments, this study attempts to: I) determine teacher understanding of the microcontroller idea II) Determine the attitude (AT) level of RBT teachers employing microcontrollers in practical teaching and learning. III) Determine if there are gender-based differences in the attitude levels of RBT teachers who teach utilizing microcontrollers.

Usually, students and teachers in secondary and primary schools in Malaysia who are interested in robotics clubs or participated in robotic competitions were among the first to learn about the development of the use of microcontrollers in the education system (Ibrahim et al., 2014). Despite this, in the year 2017, there was a reorganization of the secondary school curriculum in response to the rapidly expanding impact of digital technology advancement and the current global post-IR 4.0 attendance (Aparicio et al., 2018). The Malaysian Ministtotion (MOE) has implemented a new curriculum (KSSM) and introduced a new STEM-based subject known as Design and Technology (RBT) to replace the subject of Integrated Living Skills (KHB) to launch an extensive improvement in education as well as sustained progress in teaching and learning microcontroller. This was done to improve teaching and learning microcontroller (Ministry of Education, 2016). It is thought that microcontrollers have become a rising new trend learning as a smart digital technology (Ministry of Education, 2016)

The purpose of introducing the Design and Technology (RBT) subject was to provide teachers with a new tool for enhancing the learning level of Form 2 and Form 3 students so that they can solve engineering challenges by designing clever electronic designs in their practical projects (Bunyamin, 2018). Its involve working with approaches of developing project-based learning (PBL) by assembling the hardware such as circuit components including light-emitting diodes (LEDs), interfacing keyboard, switches, batteries, DC motor, stepper motor, LCD display, and sensors, and writing small programmed like assembly language and C Programming as a command can supplement students with creative thinking skills of higher global thinking level in understanding and practice utilizes the latest digitized technologies (Chan et al., 2013).

In connection with that, it is essential for the Ministry of Education to enhance students' computational thinking abilities by evaluating student performance with problem-based projects based on the Form 3 assessment course work (PT3) to promote a comprehensive assessment of learning (Ministry of Education, 2016). Recognizing the importance of microcontroller learning, RBT teachers as educators and facilitators need to have a high level of teaching method and important technology skills to help them cope with all the challenges that will arise in the process of teaching and learning electronic design effectively and efficiently in the classroom (Sharaf et al., 2019; Al-Awidi & Aldhafeeri, 2017).

Even though this new curriculum has some benefits, it has also caused several problems, as previous studies have shown. According to the new RBT curriculum and syllabus, previous investigations demonstrated that there are issues regarding the difficulties and pressures associated with the study of these microcontrollers (He et al., 2015). Such characteristics of microcontroller learning as a combination of various disciplines such as computer science, computer engineering, automatic control, and electrical engineering have become a contentious issue among non-engineering or novice undergraduates at tertiary level who wish to study it (He et al., 2015; Ibrahim et al., 2015; Cruz, 2017). In addition, educators face challenges in the areas of knowledge, training, and courses, insufficient microprocessor teaching allocation time for students to produce projects, a lack of facilities and additional teaching modules, and insufficient usage of tools and teaching aids in the classroom, among other issues (Sahaat & Nasri, 2020).

According to the findings of a study conducted by Sahaat and Nasri (2020), on 418 RBT secondary school teachers in Sarawak (mean value = 2.23) the teachers argue that there was a shortage of microcontroller materials and teaching aids (ABM) in electronic design teaching, and as a result, it is categorized as being at a low level. The findings of the study showed that teachers had a high level of engagement in using the teaching aids (BBM) (mean value = 3.71), but they had a poor degree of mastery of teaching abilities for each RBT application issue, including the use of microcontrollers (mean value = 2.2). Meanwhile, the findings of the study, there were limitations in terms of the allocation of teaching time and the implementation of practical work, such that the amount of time students spent setting up electronic projects was insufficient (mean value = 2.15) (Sahaat & Nasri, 2020). Consequently, the way to learn how to use microcontrollers based on hardware and software technology required more time to study in practice than it took to master its theory (Nethravathi & Geetha, 2016). This plainly demonstrated that there were issues with RBT implementation.

According to Ertmer et al (2012), the implementation of technology integration became challenging due to the impact of teachers' unfavorable attitudes and beliefs, as well as fear of being intimidated by technology while teaching. This is because a person's attitude is a very important part of their ability to accept technology (Davis, 1989). An earlier study found that 100 teachers in robotics could be produced every year on a national scale if they had a positive attitude and were obsessed with and striving to learn how to use a microcontroller board through activities that were conducted in robotics basic courses, could be taken directly by massive open online courses (MOOCs) (Filippov et al., 2017). In a similar situation, students have a positive attitude about using microcontrollers to design smart electronic hardware with multiple functions for their problem-solving projects in electronic teaching and learning (Mabbott, 2014).

In the meantime, Fisher (2006) added, teachers' attitudes and beliefs, not technology itself, are what influences how individuals use technology, these two key factors have helped technology become more effective. These statements received substantial support from previous studies, which indicated teachers' attitudes and beliefs are the primary factors that influence the successful implementation of new technologies in the classroom and the likelihood of their benefiting from training (Kluever et al., 1994; Mumtaz, 2000; Blackwell et al., 2014).Thus, if teachers like technology, they'll work to improve themselves and their instruction (Zacharia, 2003). In a similar manner, when people exhibit a negative attitude, impact feelings of influence emerge, will lead them to avoid making an effort to gain the skills necessary to adapt effective use of technology (Harrison & Rainer, 1992). As a result, the role of attitude is significant since it serves as a benchmark to determine whether there is acceptance, which permits an individual to make use of the technology (Zacharia, 2003; Kriek & Stols, 2010).

However, Chien et al (2014) found that even though teachers showed a positive attitude towards technology, it was not necessarily the case that teachers would exhibit good performance when using the technology in a classroom. This is due to the fact that the formation of attitudes towards the utilization of technology takes an extended time of application in order to adapt to the technology more effectively (Jimoyiannis, 2008). Many studies have been carried out to investigate the perspectives of educators on the implementation of a wide variety of technological tools into educational settings. Unfortunately, there was no research carried out to determine the level of attitude held by educators regarding the implementation of the microcontroller technology in the classroom.

For instance, a study that was carried out in Malaysia by Stošić, and Stošić (2015) on 143 educators working in primary and secondary schools indicated that educators had a positive attitude regarding the incorporation of internet-based instruction into educational settings. In similar research, the opinions of sixteen teachers working in elementary schools revealed that the teachers had a positive attitude towards the use of life skills multimedia software (Fadila & Chiew, 2014).

One of the demographic factors that can be found in the influences that attitudes and skills have on the utilization of technology is a person's gender (Cooper, 2006). Because there is no way around the use of technology in education, the gender composition of the teaching staff is the single most essential element that must be taken into consideration (Kutluca & Ekici, 2010). The findings of the independent t-test analysis revealed that female teachers had a more positive attitude than male teachers did regarding the implementation of mobile learning (M-learning). On the other hand, the contrary findings of a study conducted by Uzunboylu and Ozdamli (2011) showed that male teachers were more likely than female teachers to have a positive attitude regarding the application of such technology.

However, the use of information aids based on information technology among history teachers in Malaysia revealed that there was no significant relationship in terms of gender with the attitude of technology usage (Jayalatchumy, 2006). This was shown by the fact that there was no gender gap in the percentage of history teachers who used these aids (Jayalatchumy, 2006). On the other hand, the findings of other studies showed that teachers had a positive attitude towards teaching electrical design (mean value = 4.53), and they discovered that there was no significant difference (p = 0.491) between male and female teachers' attitude towards the field of electricity, which either means that male and female teachers had the same positive attitude towards the field, or that male and female teachers had the same positive attitude (Akmal, 2017). As a result, it is necessary to determine whether this issue was also affected by the attitude of the RBT teachers which can be done by investigating the perceptions of the RBT teachers' attitude level regarding the utilization of microcontroller technology in the teaching and learning of electronic design at the secondary school level. Considering the prior discussions, the following are the objectives of this study: I) determine teacher understanding of the microcontroller idea II) Determine the attitude (AT) level of RBT teachers employing microcontrollers in practical teaching and learning. III) Determine if there are gender-based differences in the attitude levels of RBT teachers who teach utilizing microcontrollers.

Research Question

1. Do the RBT teachers understand Microcontroller?
2. What is the attitude level of RBT teachers towards the use of the Microcontroller as a teaching tool and aid (BBM) in the classroom?
3. Is there a difference in the attitude level of RBT teachers teaching in using the microcontroller based on gender?

Research Hypothesis

There is no significant difference in the Attitude level of RBT teachers in using microcontrollers based on gender.

Methodology

To answer the research questions, descriptive and comparative study designs were chosen for this investigation. For data collection, questionnaire-based survey studies were utilized due to their advantages in measuring the perception, attitude, or behavior of RBT teachers towards the usage of technology. On the same day that the surveys were distributed, 128 questionnaires were gathered from RBT teachers who taught microcontrollers. Each question was evaluated using a Likert scale ranging from 1 to 6 or a 6-point asymmetric scale, with a value indicator ranging from 1 (Strongly Disagree) to 6 (Strongly Agree) (Strongly Agree). In this study, the items on each questionnaire were generated by adapting instruments from a review of relevant international journals. Previous studies, such as Lin and Williams (2015); Sadaf et al (2016); Taylor and Todd (2007), had designed and utilized a number of the existing questionnaires (1995). This study's questionnaire consisted of five sections, namely Sections A through F. To address the research questions, however, only Sections A (respondent demographics) and C (attitudes) were discussed. Adapted from research by Sadaf et al., the profile and demographics section contain six elements (2016). In addition, attitude consists of eight questions, with the first four items modified from a study by Sadaf et al (2016) and the last two items adapted by Lin and Williams (2015), with item reliability of Cronbach's alpha exceeding 0.50. (Drost, 2004). In this study, all instruments were made, modified, and adapted in accordance with the context of microcontroller technology application.

The original language of these attitude elements was English. Nonetheless, a hired linguist translated these materials. Five specialists were chosen to review and validate the item's contents: two teachers (linguistic experts) and three professors (design and technology experts). After that, the study's instruments underwent enhancements and changes. According to the study, all eight of the study's items received a high Cronbach's alpha coefficient, which was 0.764. Using SPSS software Version 26, a descriptive study and comparison of RBT instructor attitudes based on gender were conducted. The data were reviewed before analysis to make sure there was no missing data (missing value). Data were analyzed in this study to determine the average attitude level of teachers about using microcontroller boards. The six Likert scale points—very low, low, moderate, high, and very high were read as originating from (Darusalam and Hussin, 2018; Nunally, 1978).

Table 1
The Mean of Six Likert Scales for Assessing Teacher Attitude Towards Microcontroller Boards

Min value	Interpretation
1.01 - 2.00	Very Low
2.01 - 3.00	Low
3.01 - 4.00	Moderate
4.01 – 5.00	High
5.01 – 6.00	Very High

Source: Rudzi Munap (2003), *Evaluation of Executive Secretarial Diploma Program at MARA Technology University*, PhD Thesis, UKM Bangi and Nunally, J.C. (1978). Psychometric Theory. New York: Mc. Graw Hill book Company

Results
Results of the Demography of Teachers Study
Teachers' Demographic Profile?

Table 2 below summarizes the gender distribution of the respondents, who were RBT teachers from a Penang secondary school in Malaysia. Among the total (N = 128) respondents, 92 female teachers (72%), as opposed to 36 male teachers (28%) were reported. RBTs who taught Forms 2 and 3 were of different races. 112 RBT teachers in all were Malays (88%), followed by nine Chinese (7%), six Indians (5%) and just one other (1%).

Table 2
Demographics profile of RBT teachers

Category		Frequency	percentage
Gender	Men	36	28 %
	Women	92	72 %
Race	Malays	112	88 %
	Chinese	9	7 %
	Indians	6	5 %
	Others	1	1 %

Do Teachers Understand the Concept of Microcontrollers?

Refer to table 3 for demographic data resulting from the question "*Do you attending Microcontroller Training Course*?" The survey indicated that the number of respondents who participated in microcontroller-related training courses was 119 (93%) compared to just 9 respondents (7%) who had never attended microcontroller-related training courses. The involvement of RBT teachers in training courses utilizing microcontroller boards was extremely beneficial for acquiring hardware and software-based teaching aid utilization skills. In addition, the necessary assistance and training strategies for instructing using microcontroller boards. Do Teachers Understand the Idea of Microcontrollers?

Table 3
Attending Microcontroller Training Course

Attendance	Frequency (ƒ)	Percentage (%)
Yes	119	93 %
No	9	7 %

Table 4
Programing language Using by RBT teachers.

language	Frequency (ƒ)	Percentage (%)
Scratch	3	2 %
Python	1	1 %
C/C+	75	59 %
Others	49	38 %

Similarly, the results obtained in Table 4 in response to the question "What type of programming language do RBT teachers use?" demonstrate a good response by teachers in selecting programming teaching methods. Overall, (59%) or 75 of RBT teachers are interested in using the C/C++ programming language to teach and learn about microcontrollers, followed by other programming languages.

Table 5
Distribution of RBT Teachers Using Microcontroller Board

Microcontroller boards	Frequency (ƒ)	Percentage (%)
Arduino	59	46 %
Microbid	11	9 %
Magnetcode	46	36 %
Raspberry Pi	8	6 %
Adafruit Flora	1	1 %
Makeblock Mbot Robot Kit	3	2 %

Finally, table 5 demonstrates that there are a variety of microcontroller boards available on the market for RBT teachers to utilise in teaching and learning, answering the question "*What type of Microcontroller Board RBT teacher's use in teaching?*". The majority of 59 RBT teachers (46%) choose to use an open-source Arduino microcontroller board, followed by Magnetcode (36%) Meanwhile, the Microbid-type microcontroller board was less liked by teachers. Eleven RBT teachers utilised Raspberry Pi (9%), eight RBT teachers used Makeblock Mbot Robot Kit (6%), and only one teacher used an Adafruit Flora microcontroller board (1%). In addition, despite the fact that teachers demonstrate sufficient grasp of the concept of a microcontroller after receiving training, they are unable to determine the most appropriate hardware and software for microcontroller use in the classroom. Due to the infrequent use of microcontrollers in the classroom, teachers continue to be unable to increase their utilisation proficiency.

Table 6 from the "*How many times RBT teacher's using Microcontroller board in the classroom?* reveals that teachers are not frequently applied to teach using microcontroller board in the classroom. An increasing number of respondents (1–5 times) used microcontrollers in practical teaching, followed by 20 respondents who never used microcontroller in teaching and learning. 19 respondents (15%) used microcontrollers occasionally (6–10 times), while just 4 respondents (3%) used microcontrollers frequently (more than 10 times) in teaching and learning.

In addition, table 7 demonstrates in detail the response to the question "*RBT teacher self-skills level is?*", Sixty-six percent of respondents (98) were in the new learner category level in using microcontrollers in the teaching and learning practical classroom, and fifteen percent (15%) were in the moderate self-skills category. Six respondents (16%) stated that they lacked the ability to utilise a microcontroller, whereas five respondents (3%) claimed to have advanced microcontroller proficiency.

Table 6
Frequency Using Microcontroller Board in Classroom

Frequency in 10 Week	Frequency *(ƒ)*	Percentage *(%)*
0 times (Never)	20	16 %
1–5 times (Rare)	85	66 %
6–10 times (sometimes)	19	15 %
More than 10 times (often)	4	3 %

Table 7
RBT Teachers Mastering the Skills Using a Microcontroller Board

Self-skills Frequency (ƒ)	Frequency (ƒ)	Percentage (%)
Not existed	6	16 %
New beginner	98	66 %
Moderate	19	15 %
Advance	5	3 %

Distribution of Respondents by Attitude Level

This section discusses the study's findings regarding the attitude levels of RBT teachers towards employing microcontrollers in teaching and learning, including whether those attitudes were at a very high, high, medium, low, or very low level. The distribution of RBT teachers' replies by attitude level is shown in Table 8 below. 36 respondents (28%) were men, whereas 92 respondents (72%) were women.

The table reveals a moderate level of 3.93 for the mean distribution of responses. The majority of 121 RBT teachers (94.6%), with a mean attitude of 4.18 and a standard deviation of 0.524, had a high level of attitude and agreed to state, "teaching electronic design in using microcontroller excellent." Overall, the attitude of RBT teachers towards the use of microcontrollers was at a moderate level. The lowest item, "like to use a microcontroller to teach electronic design practical classes" received the least amount of support from 61 RBT teachers (47.7%) (mean = 3.38; SD = 0.922). This indicates that, using a proportion between 94.6% and 83.6%, mean = 4.20 to 4.01, as a cutoff indicative of a high level of teachers' attitudes, it's possible to conclude that the majority of RBT teachers agreed with the benefits, and importance of using microcontrollers in teaching. According to the percentage between 78.1% and 47.7%, mean = 3.98 to 3.38, used as a cutoff indicator of the level of RBT teachers' attitudes, it was moderately agreed that microcontrollers might aid students in finishing their practical projects and that teachers felt it less enjoyable and satisfying to use microcontrollers in the classroom while instructing students.

Table 8
Distribution of RBT teachers' respondents by attitude level

Items	Scale						Total	Mean	SD	Level
	1 SD	2	3	4	5	6 SA				
For me, teaching electronic design using a Microphone is very beneficial	0 (0.0)	8 (6.3)	-	87 (68.0)	-	33 (25.8)	120 (93.8)	4.20	.533	High
For me, teaching electronic design by using a Microphone is very important	9 (7.0)	-	-	90 (70.3)	-	29 (22.7)	119 (93)	4.16	.524	High
For me, teaching electronic design by using a Microphone is a lot of fun	1 (0.8)	15 (11.7)	50 (39.1)	44 (34.4)	17 (13.3)	1 (0.8)	62 (48.5)	3.50	.922	Moderate
For me, teaching electronic design by using Microphone is an excellent idea	-	-	7 (5.5)	92 (71.9)	28 (21.9)	1 (0.8)	121 (94.6)	4.18	.524	High
For me, the use of microcontrollers helps to teach the translation of schematic and pictorial drawings to students	-	1 (0.8)	20 (15.6)	83 (64.8)	22 (17.2)	2 (1.6)	107 (83.6)	4.03	.651	High
For me, the use of microcontrollers facilitates the teaching of programming languages to students	-	-	19 (14.8)	89 (69.5)	20 (15.6)	-	109 (85.1)	4.01	.554	High
For me, the use of microcontrollers helps teach students design practical projects	-	2 (1.6)	26 (20.3)	74 (57.8)	25 (19.5)	1 (0.8)	100 (78.1)	3.98	.704	Moderate
I like to use microcontrollers to teach electronic design practical classes	-	26 (20.3)	41 (32.0)	48 (37.5)	13 (10.2)	-	61 (47.7)	3.38	.922	Moderate
Overall								3.93	0.666	Moderate

Distribution of Respondents by Attitude Level by Gender

To determine the differences in attitude levels among RBT teachers in implementing teaching by using the microcontroller based on gender, an independent sample t-test was utilized. As a result, the study's findings were as follows:

Table 9
Test of differences in the level of RBT teachers' attitude by using microcontroller based on gender.

Construct	Gender	**N 128**	**Mean**	**SD**	**T**	**df**	**Sig (2-tailed)**
Attitude	Men	36	3.97	0.41673	0.870	64.847	0.388
	Women	92	3.90	0.42293			

**Significant level at 0.05

Table 9 shows the results of gender differences in attitude levels among RBT teachers when implementing teaching and learning on the use of microcontrollers. As a result of the Levene test for variance equality, the value of F = 0.383, sig, 0.537, exceeded p> 0.05. It could then be concluded that both samples (gender) originated from the same population or were homogenic. Meanwhile, the t-test for comparing men's and women's attitude levels yielded a value of t (64.847) = 0.870, p =.388. The null hypothesis was accepted because this p value indicated a significant level greater than 0.05 (p 0.05). As a result, there was no significant difference in attitude between male and female teachers. The difference in mean value was also not statistically significant, with RBT male teachers having a mean value of 3.97, which was slightly higher than female teachers, who had a mean value of 3.90.

Discussion

Do Teachers Understand the Microcontroller Concept?

Generally, RBT teachers have insufficient knowledge and skills, and they are still at the beginning of teaching using microcontroller boards as newcomers. although the new curriculum has only been implemented since 2017, and they officially started teaching microcontrollers in 2018. The teachers have shown success in training courses that allow them to develop both their theoretical knowledge and their practical abilities in the field of teaching using microcontrollers. Although, the findings show that teachers are not often involved in the practical application of microcontrollers during their teaching period in the classroom. Teachers have a positive attitude towards the use of appropriate hardware and efficient software in the classroom, show that RBT teachers understand the microcontroller concept. For example, they use the Arduino microcontroller and C/C+ assembly language to help students understand the structure of the microcontroller, including instruction format, control structure flow, hardware stack operations and interrupts (He et al., 2015). This finding is in line with the statement asserted by Ertmer et al (2012) that attitudes and beliefs are among the most important factors in the successful implementation of technology integration in the classroom. However, positive attitudes are not the only factors that will determine the extent to which technology can be successfully adapted and implemented in the classroom (Chien et al., 2014). In order to confirm that aspect, the researcher will continue to research and deepen the level of attitude shown by RBT teachers while using the microcontroller in future sessions to determine the possibility of a decision.

What is the attitude level of RBT teachers towards the use of the Microcontroller as a teaching tool and aid (BBM) in the classroom?

Overall, the level of attitude of RBT teachers towards the use of microcontrollers in teaching and practical learning of electronic design is at a moderate level, with a mean score of 3.93. This shows that RBT teachers generally have the idea to use this device. A range of scores ranging from 3.38 to 3.98, is also considered moderate difficulty. This low level of confidence shows that RBT teachers are still not sure how to fully use microcontrollers when teaching hands-on projects to students. Where, the level of attitude of the teachers is moderate using the microcontroller. Because RBT teachers are very optimistic and aware of the benefits, and the importance of teaching and the benefits obtained from the use of microcontrollers in their teaching and their daily lives. The teachers still show a positive attitude about the project being carried out. However, they are still unsatisfied and less interested in the way they teach the use of microcontrollers and think that the use of microcontrollers does not help students make practical projects that are completed accurately. Causes RBT teachers less apply microcontroller in their classroom, because hardware and software-based microcontroller usage applications are not so easy to understand, and further efforts are needed to make them easier to use so that problem-solving techniques in digital electronic circuits and a deep understanding of how microcontroller devices work are known in detail (He et al., 2015; Mallik & Rajguru, 2018). This is why, RBT teachers less apply microcontroller in their practical teaching.

The results of the study are consistent with the statement by (Othman and Omar, 2014). Although teachers like to use visual aids in the classroom, they still do not use them often. On the other hand, most previous studies found that both teachers and students have positive attitudes and think that learning how to use microcontrollers is entertaining. This is contrary to current findings (Filippov et al., 2017; Sharaf et al., 2019). It was also found that teachers' attitudes and understanding improved when they used Arduino microcontrollers because of following the course presented to develop in their teaching (Kocijancic, 2019). Furthermore, the study also found that students are interested in learning computerized thinking learning methods such as microcontrollers provided in the form of game teaching environment concepts (Sharaf et al., 2019).

Therefore, in this study, the teacher's attitude is the main predictive factor to the use of new technology. This matter has been discussed in many studies based on theoretical models such as the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB) as an important tool to measure teachers' attitudes towards the development of technology, which is influenced by the teacher's intentions. Which, intention is an important tool to measure teachers' attitude towards technological development (Kao et al., 2018; Scherer et al., 2015; Kao & Tsai, 2009; Almusalam, 2001).

Is There Any Difference in the Attitude Level of RBT Teachers Teaching Using Microcontroller Based on Gender?

There is evidence from a few different research that gender influences attitude (Venkatesh et al., 2000; Venkatesh & Morris, 2000; Venkatesh et al., 2003). Teachers' characteristics, such as an individual's educational level, age, gender, educational experience, experience with the computer for educational purposes, and financial position, can influence the adoption of an innovation. For example, a teacher's educational level, educational experience, and educational experience with the computer for educational purposes (Rogers, 1995; Schiller, 2003). Thus, a comparison investigation of the attitude levels of RBT teachers' teaching in using microcontroller based on gender revealed that there was no significant difference between the two groups. These findings were consistent with those of a study that was carried out by Al-Emran et al (2016), which found that there was no difference between the sexes in terms of the utilization of mobile learning in the context of teaching and learning. Although male and female RBT teachers had similar perceptions of both aspects of attitude, the mean score difference indicated that female teachers who showed high attitude aspects were concerned with the use of microcontrollers in teaching as opposed to male teachers. This was the case even though male and female RBT teachers had similar perceptions of both aspects of attitude. The positive attitude lends support to the conclusions of a study conducted by Cooper and Heaverlo (2013), which showed that women had a greater interest in STEM activities including creative problem solving and design abilities. The study found that women had this interest.

Conclusion

The purpose of this study is to examine the level of use of microcontroller attitude among RBT teachers in teaching practical assignments. In addition, the purpose of this study is to find out if there is a relationship between the gender of RBT teachers and their attitudes. The findings of the study show that the level of attitude held by RBT teachers is moderate. In other words, the attitude of RBT teachers refers to the sentiment of fun and interest in teaching microcontrollers by collaborating and trying to make practical teaching more interesting so that students can be creative in creating designs. This allows more space for students to express their individual creativity when producing designs. The result is that educators' attitudes need to change as soon as possible to encourage the use of microcontrollers in teaching and learning, which affect a person's affective, cognitive, and behavioral states (Kreijns et al., 2013). Because of this, it has the potential to improve teachers' achievements in teaching and learning, further enabling students to build various creative and original smart electronic technology projects based on microcontrollers in practical classrooms. In addition, the findings of the study show that only a small part of RBT teachers, specifically 7%, did not participate in the microcontroller course. Despite this, the findings of the study show that RBT teachers believe their skills in using microcontrollers are still at a new level or just beginning.

In fact, the frequency of microcontrollers usage among teachers is still at a rare level, 1–5 times (66%) only with a time allocation of 10 hours in the microcontroller syllabus (Sahaat & Nasri, 2020). This contrasts with the experimental study time conducted by Pao (2018), who used it for 3 hours in 16 weeks or 28 hours (Pao, 2018). In the experimental study, microcontrollers were used for a total. In the meantime, according to the preferences of teachers regarding hardware and software microcontrollers, it was discovered that the Arduino microcontroller was the most popular choice among teachers (46%), as well as the C programming language (59%), in comparison to Python (1%) and Scratch (2%). According to these findings, Arduino is one of the microcontrollers that is used in the classroom and in industry the most frequently due to its capabilities, its ease of use, and the open-source programming environment that it provides (Titovskaya et al., 2019). The findings of this analysis can also assist stakeholders in formulating a policy about whether there are additional requirements for enhancing the degree of teachers' attitudes held by RBT teachers regarding teaching and learning facilities.

According to what Sahaat and Nasri (2020) suggested, there was a need for relevant stakeholders, such as the Curriculum Development Division in the Ministry of Education Malaysia and the Institute of Teacher Education, to increase the teaching time and improve the equipment facilities in the workshop to facilitate the teaching process for students. As a result, RBT workshops can be upgraded to "makerspace" or "Collaborative Environment," which refers to a space with the technology prototyping concept of STEM teaching tools that can process various teaching techniques to cultivate digital technology for developing an idea for constructing physical and digital inventions through teamwork involving educators and students. This type of space can process various teaching techniques to cultivate digital technology for developing an idea for constructing physical and digital inventions (Sheridan et al., 2014; Tan, 2019). It is also used as a future innovative space for students to develop problem-solving skills and for successful practical teaching activities of RBT teachers to students. This allows it to cover a wide spectrum of teaching objectives, including those in science, technology, mechanical engineering, electrical and electronics, as well as the arts (Pao, 2018).

Studies have shown, through the utilizations of this idea, that there has been an expansion of information as well as an improvement in students' and teachers' problem-solving abilities in the fields of computer programming and electrical engineering (Pao, 2018). However, in the future it is proposed to investigate the same questions by covering all schools in Malaysia and involving students. In addition, the scope of the research will be expanded to investigate the relationship between teacher behavior and the utilization of microcontrollers in the instruction and education of electronic design.

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