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# Attitude and Perception towards Microcontroller Education among Rural Area Students in Malaysia

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**ABSTRACT**

The statistic of student enrollment in the field of Science, Technology, Engineering and Mathematics (STEM) in Malaysia is declining every year. This scenario is quite worrisome by many stakeholders. One of the initiatives taken to increase students' interests in the field of STEM is by using microcontroller in the school curriculum. However, schools in rural area might not have the appropriate kit for the purpose. Thus, the aim of this study is to investigate the relationship of attitude and perception of students in rural areas of Malaysia towards the microcontroller education. A total of 200 students from 16 secondary schools in rural areas across four districts, each from a different state, attended the microcontroller workshops. The instrument used in measuring the students' attitude and perceptions is a questionnaire using five-point Likert scale, which was answered after the workshop completed. The result showed that the attitude and perception of rural area students towards microcontroller education are at a high level. Pearson correlation result obtained in attitude and perception of the students in microcontroller education poses the positive relationship with moderate strength. These findings reveal that when appropriate microcontroller kit is made available to students, this will promote students' interest in STEM education and could mitigate the lack of enrollment in STEM related field in higher education.

***Keywords:***
Attitude; microcontroller education; perception; STEM

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|---|---|---|---|

## 1. Introduction

The number of students venturing into the Science, Technology, Engineering and Mathematics (STEM) fields of studies in Malaysia has been declining year by year [1,2]. This tendency is concerning since STEM fields are crucial for technological advancement and economic development. According to Huda [3], the STEM fields are frequently perceived as tough, which discourages many students from pursuing them. Young minds can be dissuaded from pursuing education in STEM fields due to this misperception. In addition, many schools in Malaysia lack inadequate funding and resources for STEM programmes, particularly those in rural areas [3]. On the other hand, STEM education, which

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integrates science, technology, engineering, and mathematics, is more widely acknowledged for its role in developing a comprehensive and interconnected knowledge system among students [4,5]. STEM education intends to assist students apply theoretical knowledge in real-world situations, encourage interdisciplinary connections, and develop both skills and knowledge [6]. The integration of technology and engineering knowledge into problem solutions that are encountered in daily life is a crucial aspect of implementing STEM education. According to Kocak *et al.,* [6], STEM education enables students to identify problems and provide solutions. Engaging in STEM activities can help individuals develop abilities to create solutions for multiple problems.

In addition, STEM forms the educational approach used by many different countries. Because it is widely acknowledged that individuals possessing STEM education credentials and a comprehensive understanding of various disciplines will be in high demand in the future. To put it another way, the integration of STEM education within the academic programme is of utmost significance for the next generation [7]. Wang *et al.,* [4] stated that the STEM framework demonstrates a conceptual model for integrating multiple disciplines, while a more precise integration approach is still required. Educational values, especially those concerning individual cognitive development, are important in STEM learning and should be thoroughly addressed in the context of new educational models [8].

Nevertheless, the integration of these fields frequently requires clarification. To compensate for this, several initiatives have been introduced to engage students in exploring opportunities in the STEM fields, particularly microcontroller development courses that can encourage interdisciplinary learning and application. Microcontrollers are compact computer systems that include a processor, memory, input/output peripheral devices, and custom firmware code for hardware control on a single chip. Advancements in technology can be classified into hardware-related and software-related advancements.

Microcontrollers play a crucial role in various electronic devices, driving innovation across industries like smart homes and transportation [4]. To meet the growing demand for skilled microcontroller engineers, educational institutions must enhance their teaching approach and curriculum. By improving the quality of microcontroller courses, they can better engage students for careers in exploring opportunities thereby ensuring they make significant contributions to the industry's growth and development. Reports have indicated a robust expansion in the global microcontroller market in the future, where there is a growing demand for professionals skilled in microcontroller engineering [9]. This surge in demand is driving an increase in enrolment in microcontroller courses. Consequently, it is imperative to enhance the quality of instruction in these courses to meet the needs of aspiring students who rely on microcontrollers for their projects and careers [10].

In Malaysia, integrating microcontroller topics within Design and Technology (Reka Bentuk dan Teknologi - RBT) subjects is crucial for meeting defined learning standards [11]. Basic programming languages like Scratch, incorporated in primary school RBT subjects, lay the groundwork for understanding microcontrollers. As students' progress to secondary school, learning robotics ignites their interest in the field and allows for practical application across science subjects [12]. By incorporating engineering elements such as robotics into teaching, educators can help students connect scientific principles with everyday experiences, fostering interest in robotics and microcontroller programming [13]. Teaching robotics serves as an engaging approach to imparting microcontroller education and programming skills to students [14].

Schools in rural areas contribute significantly to the education of the populace of a nation. In real life, however, they frequently receive less attention from the government as it strives on its reform agenda. This is probably caused by the usual location of the education office in urban areas and the isolation of rural schools [15]. Rural students typically achieve lower scores in Science and

Mathematics compared to urban students [16]. Unfortunately, location has an impact on critical thinking in Science and Mathematics performance [17]. However, the difficulties of teaching in rural areas are not restricted to Malaysia and are widespread in several different countries [18]. As of 2019, over 3 million people living in remote areas of Malaysia [18]. Sabah and Sarawak are the two states have the least developed infrastructure compared to other states in Malaysia, resulting in a higher proportion of rural schools [19].

Murphy *et al.,* [20] define student attitudes towards STEM education and desire as 'STEM dispositions' and emphasis that positive self-perceptions in these fields are crucial for continued involvement. They argue that establishing these positive perceptions early on is crucial for fostering interest [20]. Additionally, Marginson *et al.,* [21] elucidate that certain students hold a negative perception of STEM education due to the misconception that it is reserved for individuals with innate 'talents' rather than being attainable for students through hard work. Positive perceptions of STEM are crucial for student involvement; hence it is important to identify the components of STEM education that impact student perceptions.

### *1.1 Research Questions*

Our study aims to investigate the relationship between the attitude and perception of students in rural areas of Malaysia towards microcontroller education. Hence, our research questions (RQ) are:

i. RQ 1: What is the students' level of attitude towards microcontroller education?
ii. RQ 2: What is the students' level of perceptions towards microcontroller education?
iii. RQ 3: Is there any significant relationship between students' attitudes and perceptions towards microcontroller education?

### *1.2 Research Objectives*

In order to achieve our aims, we have set the study's objectives as follow:

i. Objective 1: To determine the students' level of attitude towards microcontroller education
ii. Objective 2: To determine the students' level of perceptions towards microcontroller education
iii. Objective 3: To investigate the relationship of students' attitude and perceptions towards microcontroller education

$H_0$: There is no significant relationship between students' attitudes and perceptions towards microcontroller education.

$H_1$: There is a significant relationship between students' attitudes and perceptions towards microcontroller education.

### *1.3 Conceptual Framework*

Figure 1 shows the suggested conceptual framework of this study, depicting the relationship between perception, attitude, microcontroller education, and interest in STEM. We postulate that if students have positive perception and attitude towards microcontroller education, they would have enthusiasm to pursue STEM fields.

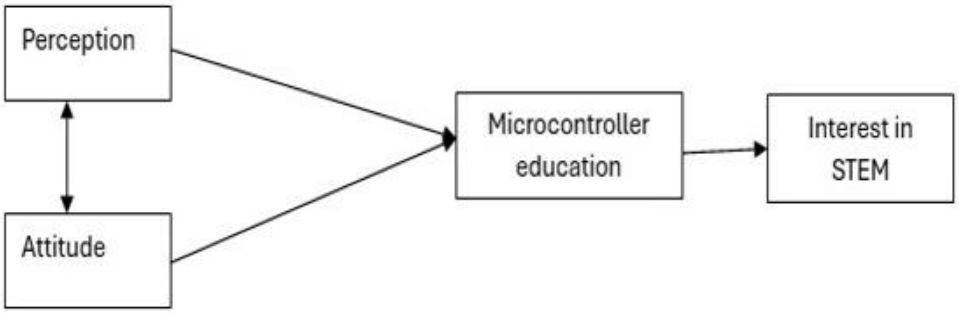


**Fig. 1.** Conceptual framework

## 2. Methodology

This study employed quantitative design using a survey research method to determine attitude and perception towards microcontroller education among rural area students in Malaysia.

### *2.1 Research Instruments*

The study used an instrument that was divided into three sections. The first part gathered information about the students' background, the second part contained 14 items related to the students' attitudes, and the third part consisted of 9 items focusing on the students' perceptions of microcontroller education among rural students in Malaysia. The questionnaire for attitude and perception used in this study was developed and modified based on the research done by Soh *et al.,* [22] and Hagan [23]. While the questionnaire on Table 1 shows the number of items for the construct used in this study.

**Table 1**
Research construct

| Construct | Number of items |
|---|---|
| Attitudes toward microcontroller education | 14 |
| Perceptions toward microcontroller education | 9 |

Therefore, a total of 23 items were used to measure the two concepts. The questionnaires used a five-point Likert scale, with responses ranging from Strongly Disagree (1) to Strongly Agree (5), enabling respondents to express their views on each item.

According to Sudaryono *et al.,* [24], validity is a measuring instrument to gauge the extent of what should be measured in the study. Fraenkel and Wallen [25] also stated that the validity of the study refers to the relevance, accuracy, usability, and significance of an inference that the researchers can obtain from the data collected using instruments built. Since the instrument was adopted from previous studies, we can consider this instrument valid. In addition, a pilot study was conducted to obtain the reliability index of the instrument. Table 2 presented the alpha reliability (coefficient alpha) ranged from 0.807 – 0.870 for the 2 constructs. Table 2 shows the reliability of the instruments used in this study. The Cronbach alpha coefficient value for item construct 1 was 0.807 and the item construct 2 was 0.870. It indicates that both item constructs consist high level of internal consistency with respect to the sample (n = 200).

**Table 2**
Scale reliability using Cronbach's Alpha coefficient for the construct

| Construct | α reliability |
|---|---|
| Attitudes toward microcontroller education | 0.807 |
| Perceptions toward microcontroller education | 0.870 |

N=200

### *2.2 Research Sample and Population*

This study employed cluster sampling to select participants from 16 secondary schools located in rural areas across four states in Malaysia: Arau, Perlis; Machang, Kelantan; Raub, Pahang and Dengkil, Selangor. A total of 200 students were selected using simple random sampling to participate in the study. Cluster sampling method is a two-way procedure which is overall population was divide into groups or cluster of typically locales. This method of sampling is beneficial for survey conducted on large geographical area [26]. Based on the table presented by Krejcie and Morgan [27], the sample size that should be taken for rural area is 199 respondents (to represent a population of 2,424 form three students from rural area in four states). Therefore, the minimum number of samples required to obtain relevant population parameters are about 199 respondents.

### *2.3 Data Analysis Procedures*

Data is processed using the Statistical Package for Social Sciences (SPSS) using descriptive statistics to obtain the mean, standard deviation, frequency, percentage. In order to identify the relationship of the students' attitude and perceptions towards microcontroller education, a statistical inference such as Pearson correlation analysis was employed in this study.

## 3. Results and Findings

### *3.1 Normality Test*

In this study, normality test was done by using Shapiro-Wilk, the p-value was found to be more than 0.05 and thus it was interpreted that the sample is normally distributed. For normality test, correlation should be closed to one. Null hypothesis was rejected when the correlation coefficient was small value [28].

### *3.2 The Level of Students' Attitude and Perceptions Towards Microcontroller Education*

Objectives 1 and 2 sought to determine the level of students' attitudes and perceptions towards microcontroller education. It was determined based on the mean score interpretation in Table 3 [29].

**Table 3**
Mean score interpretation [29]

| Mean Score | Interpretation |
|---|---|
| 1.00 - 1.80 | Very low |
| 1.81 – 2.60 | Low |
| 2.61 – 3.20 | Medium |
| 3.21 – 4.20 | High |
| 4.21 – 5.00 | Very High |

Based on Figure 2, the result revealed the overall mean score of students' attitudes toward microcontroller education is very high with a mean score of 4.53. Meanwhile, the overall level of students' perceptions of microcontroller education was also very high with a mean score of 4.34.

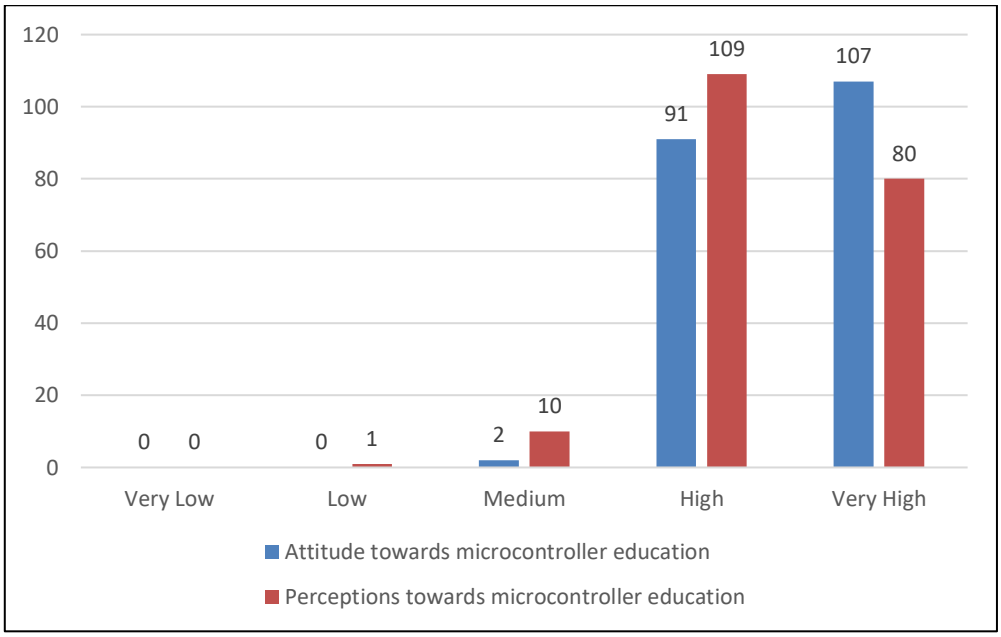


**Fig. 2.** Students' attitude and perceptions toward microcontroller education

*3.2.1 Objective 1: To determine the students' level of attitude towards microcontroller education*

Table 4 shows the fourteen sub-constructs of students' attitudes towards microcontroller education. Feedback was collected on the students' perceptions of microcontroller education. The result of the study shows that the students' attitudes towards microcontroller education are positive and very high with an overall mean obtained is 4.53 as reported in Table 4. The highest positive attitude shown by the student was; I think Arduino is important to national development (Mean= 4.55, SD = 0.58). The other common attitudes show by the student towards microcontroller are; I enjoy learning Arduino (Mean = 4.46, SD = 0.62) ,Knowledge of Arduino useful to me (Mean = 4.42, SD = 0.63), I think Arduino should be studied be every student (Mean = 4.36, SD = 0.75), I think the subject of Arduino consists of activities or projects that teach students to think critically and creatively (Mean = 4.36, SD = 0.65), I love doing Arduino experiments in the laboratory (Mean = 4.35, SD = 0.74), I think Arduino can improve one's life (Mean = 4.34, SD = 0.64), I think the subject of Arduino consists of activities or projects that encourage students to explore and investigate (Mean = 4.32, SD = 0.65) , I think the subject of Arduino can provide basic knowledge to further my studies in STEM (Mean = 4.32, SD = 0.77) , I think the subject of Arduino helps prepare me to face the challenges of technology in the 21st century (Mean = 4.31, SD = 0.68), I think the knowledge I acquired from the study of Arduino can be used in my daily life (Mean = 4.27, SD = 0.75), I like to follow the latest developments in science and technology (Mean = 4.16, SD = 0.75) , I think most topics in Arduino are related to my life (Mean = 4.15, SD = 0.71) and Arduino is less interesting to me (Mean = 2.26, SD =1.36).

**Table 4**
Level of attitude towards microcontroller education

| Criteria | Mean | Standard Deviation | Interpretation |
|---|---|---|---|
| (S1) Knowledge of Arduino is useful to me | 4.42 | 0.63 | Very High |
| (S2) I think most topics in Arduino are related to my life | 4.15 | 0.71 | High |
| (S3) I think the knowledge I acquired from the study of Arduino can be used in my daily life | 4.27 | 0.75 | Very High |
| (S4) I think Arduino can improve one's life | 4.34 | 0.64 | Very High |
| (S5) I think Arduino is important to national development | 4.55 | 0.58 | Very High |
| (S6) I think Arduino should be studied be every student | 4.36 | 0.75 | Very High |
| (S7) I like to follow the latest developments in science and technology | 4.16 | 0.73 | High |
| (S8) I enjoy learning Arduino | 4.46 | 0.62 | Very High |
| (S9) I love doing Arduino experiments in the laboratory | 4.35 | 0.74 | Very High |
| (S10) I think the subject of Arduino consists of activities or projects that teach students to think critically and creatively | 4.36 | 0.65 | Very High |
| (S11) I think the subject of Arduino consists of activities or projects that encourage students to explore and investigate | 4.32 | 0.65 | Very High |
| (S12) I think the subject of Arduino helps prepare me to face the challenges of technology in the 21st century | 4.31 | 0.68 | Very High |
| (S13) I think the subject of Arduino can provide basic knowledge to further my studies in STEM | 4.32 | 0.77 | Very High |
| (S14) Arduino is less interesting to me | 2.26 | 1.36 | Low |

### *3.2.2 Objective 2: To determine the students' level of perceptions towards microcontroller education*

Table 5 revealed the result of students' perceptions towards microcontroller education with nine sub-constructs. Items were submitted for students' feedback on their perceptions of microcontroller education. From Table 4, the overall perceptions of students were positive and very high on the microcontroller education (Mean = 4.34). There are two items construct received very high perception by the student which are; I enjoy studying Arduino (Mean= 4.39, SD = 0.71) and I have an interest in studying Arduino (Mean= 4.28, SD = 0.75) as reported in Table 5. Meanwhile, the lowest mean score was perception regarding the topics in Arduino are easy to learn (Mean = 3.83, SD = 0.81).

**Table 5**
Level of perception towards microcontroller education

| Criteria | Mean | Standard Deviation | Interpretation |
|---|---|---|---|
| (S15) I have an interest in studying Arduino | 4.28 | 0.75 | Very High |
| (S16) I enjoy studying Arduino | 4.39 | 0.71 | Very High |
| (S17) I rate Arduino equally high to all other core subjects | 3.97 | 0.70 | High |
| (S18) Arduino is important in our daily interactions | 3.92 | 0.82 | High |
| (S19) The topics in Arduino are easy to learn | 3.83 | 0.83 | High |
| (S20) I enjoy sharing mathematical solution strategies with my colleagues | 4.19 | 0.71 | High |
| (S21) I would like to pursue further studies in STEM | 3.88 | 0.88 | High |
| (S22) Arduino should continue to be a core subject | 3.86 | 0.83 | High |
| (S23) Every student need Arduino knowledge | 4.05 | 0.86 | High |

### *3.3 The relationship on students' attitude and perceptions towards microcontroller education*

Objective 3: To investigate the relationship of students' attitude and perceptions towards microcontroller education

$H_0$: There is no significant relationship between students' attitudes and perceptions towards microcontroller education.

$H_1$: There is a significant relationship between students' attitudes and perceptions towards microcontroller education.

To find the relationship in this study, we used an estimated strength rating, based on Pearson's correlation coefficient r (r = −1 to +1) by [28] as shown in Table 6.

**Table 6**
Correlation coefficients [29]

| Correlation coefficient | Degree of Correlation |
|---|---|
| ± 0.70 - 1.00 | High / Strong |
| ± 0.30 - 0.69 | Moderate/ Average |
| ± 0.10 - 0.29 | Low/Weak |
| 0.00 | No correlation |

The analysis result in Table 7 shows that there is a significant relationship between students' attitudes and perceptions towards microcontroller education for this sample study (n=200). The Pearson correlation strength between attitudes and perception show moderate with a positive correlation at a value of r = 0.547 and p-value < 0.01. The study has to reject the null hypothesis. Therefore, the study concludes that there is a moderate and positive relationship between attitude and perception towards microcontroller education among rural area students in Malaysia.

**Table 7**
Correlation coefficients

| | | Student's Attitude | Student's Perception |
|---|---|---|---|
| Student's Attitude | Pearson Correlation | 1 | .547** |
| | Sig. (2-tailed) | | .000 |
| | N | 200 | 183 |
| Student's Perception | Pearson Correlation | .547** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 183 | 183 |

**. Correlation is significant at the 0.01 level (2-tailed).

## 4. Conclusion

As the study was conducted to see the acceptance and response of the students towards the microcontroller education, the major aspects to be investigated are the attitude and the perception of the students before and after the learning occur. This is to ensure the process of teaching and learning of the microcontroller is effective and well-received by the students. This is based on the declining of interest among youngsters towards education in Science, Technology, Engineering, and Mathematic (STEM) field. Microcontroller education is one of the cultivations in STEM field in which most of the youngsters in rural areas are left behind. To ensure the objective of the teaching and learning of microcontroller education is achieved which is to raise the interest of students in rural area towards the microcontroller education, the aforementioned two (2) major aspects need to be analysed as it will determine the effectuality of the delivery, content, and process. Therefore, the study on attitude and perception of students in rural area towards microcontroller education was performed.

As presented in section 3 result and findings, the analysis showed that both attitude and perception of rural area students towards the microcontroller education are at high level. The analysis was executed to determine the highest mean score of the five-point Likert scale survey results that led to the levels interpretations. With high level of attitude of the students towards the microcontroller education, it is proven that the students are well-aware with the importance and significance of the Arduino or generally the microcontroller that is vital in robotic and automation systems for the development and needs of the country.

The students also proved that despite of the lack or absence of facility in technology or specifically the microcontroller devices for learning purposes, their interest towards the microcontroller education is strong and they enjoyed learning the technology through the Arduino. This was proven with the high-level perception of the rural area students towards the Arduino pedagogy. This also shows that the content of the program was effective for the students, and it could manifest the interest of the youngsters in microcontroller education. Nevertheless, the result also depicted that the microcontroller education is quite hard to learn since the mean score obtained was low. This can drive to the significance of the microcontroller teaching to the students to improve awareness and understanding.

The results obtained in attitude and perception of the students in microcontroller education pose the positive relationship with moderate strength. This proves the positive correlation between the major aspects that were used to determine the level of acceptance and responses of the rural area students towards microcontroller education. Thus, a significant relationship is occurred between the attitude and perception of the rural area students in learning the Arduino. The outcome contributes to the level of importance of both aspects in determining the effectiveness of the program including its content and delivery process for the improvement and awareness of microcontroller knowledge among the rural area students.

As percentage of students choosing STEM field in pursuing their education in school or higher level is getting lower, exposure towards the significance and vitality of STEM education to the youngsters is importance, especially for the national technology development. Through the Arduino program that injected the education in microcontroller, which is a part of the STEM field, the interest of the students was elevated. This is proven with the analysis conducted on attitude and perception of the rural students that were exposed to the microcontroller education through the Arduino program. The results of both attitude and perception including their correlation proved that the rural students still have the inquisitiveness and awareness towards the microcontroller education despite of the shortfall of facilities in learning the Arduino. The content of the program was proven its

effectiveness in manifesting students' interest and enjoyment with the positive results obtained in the analysis.

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