# Study on Knowledge and Skills in Programming and Microcontroller Courses Among Arau Lower Secondary School

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## ABSTRACT

**Background and Purpose:**

Knowledge and skills in programming and microcontroller courses among lower secondary school students are crucial as they will affect the number of enrolments in technical courses for upper secondary school students. Hence, this study was conducted to identify the knowledge and skills in programming and microcontroller courses among lower secondary school students and discuss its impact on their preferences for courses during the upper secondary school level. The study was carried out among 50 lower secondary school students in Arau district aged between 13 to 15 years old.

**Methodology:**

The study was carried out among 50 lower secondary school students in Arau district in Perlis aged between 13 to 15 years old. The students were chosen by using purposive sampling; to represent the lower secondary students' population where age is the key criterion. A quantitative approach that consists of 18 items with 2 sections was used as the instrument in this study to determine the level of knowledge and skills in microcontrollers and programming courses.

**Findings:**

The data has then been prudently analysed. The objective of the analysis is to gain a deeper understanding of the level of knowledge and skills in programming and microcontroller courses among Arau lower secondary school students. The result of the study demonstrated that the majority of students have basic knowledge and skills in programming and microcontrollers.

**Contributions:**

It can be concluded that the basic knowledge and skills in programming and microcontrollers could affect the enrolments in technical courses for secondary school students.

**Keywords:** Programming Course, Microcontroller Knowledge, School Students, Secondary School, Knowledge and Skills

# INTRODUCTION

With the emergence of Fifth Industrial Revolution 5.0 (IR 5.0), element of science, technology, engineering, and math (STEM) seems to be most vital components in education industry. At the moment, STEM education in schools in Malaysia is very important as it encourages students to think critically, analyse problems and develop innovative solutions (Rajaendram, 2023). To develop knowledgeable and skilled human capital, Malaysia's Ministry of Education targets to have 60% of students taking up the STEM stream in its 2013-2025 Education Blueprint. A beginner-friendly approach in the school curriculum supports the strategy for school students to learn the basics of programming and electronics in a fun and engaging way. Furthermore, various programs held to increase the interest and percentage of student participation in the STEM field. However, the challenge is to make building STEM projects for these students very simple while fostering their creativity and problem-solving abilities. Hence, this paper aims to study the knowledge and skills in programming and microcontroller courses among Arau lower secondary school students where the students' knowledge in a microcontroller course as well as their interest in the programming subject will be analysed. In context of Arau district, Arau is located in northwestern coast of Peninsular Malaysia, Perlis. Perlis is the smallest state in Malaysia and border with Thai provinces, with population around 261,000 in 2020 (Jabatan Perangkaan Malaysia, 2020). Some schools and students that have been chosen in this study are coming from schools in rural area, students with family background B40 income range, and students who pursue Reka Bentuk & Teknologi (RBT or Design & Technology) or Asas Sains Komputer (ASK or Computer Science Basics).

# LITERATURE REVIEW

### Secondary School in Malaysia

According to Malaysia Education Blueprint 2013-2025 produced by Ministry of Education, lower secondary level refers to student in Form 1 to 3 and upper secondary level refers to student in Form 4 to 5. Malaysia has over 10,000 schools, approximately 5 million students, and 420,000 teachers from pre to high school (Muhammad et al,2024). Currently the secondary students in Malaysian uses the Kurikulum Standard Sekolah Menengah (KSSM) or Standard Secondary School Curriculum (SSSC). Under the KSSM curriculum, lower secondary students learn a diverse range of subjects, providing them a breadth of knowledges and experiences as that explore their potential and talent. Students performance is then assessed under Pentaksiran Berasaskan Sekolah (PBS or School-Based Assessment).

Secondary education is the continuation of primary school education. In Malaysia, there are different types of Secondary Schools. Here are some types of Secondary Schools; National Secondary School (Daily), Fully Residential School (SBP), Art School, Sports School, Religions Secondary Schools (SMKA), MARA Science Junior College (MRSM), Vocational Colleges and Technical Institutes, Royal Military College (MTD), Government Aid Religious School (SABK). In 2021, there were around 2,444 public secondary schools in Malaysia, which include government or government-aided schools. In the same year, there were 167 private secondary school. The number of both public and private secondary schools has slightly increased compared to the previous year (Statista Research Department, 2023).

Reka Bentuk & Teknologi (RBT or Design & Technology) and Asas Sains Komputer (ASK or Computer Science Basics) are among subjects with school-based assessment. RBT is a new subject that replaces Kemahiran Hidup Bersepadu (KHB) subject. There are significant changes in terms of its learning standards, which now focus more on design ideas, the use of current manufacturing technology, structured problem-solving methods, and project development. The implementation of this new curriculum for the RBT subject is seen to equip students with the knowledge and skills needed in today's world. The Ministry of Education is committed to enhancing the quality of student development in line with aspirations to place Malaysia among the world's best (Ministry of Education Malaysia, 2013).

According to Razali et al. (2020), the idea of using the curriculum to KSSM is by strengthening and introducing STEM in the education system of Malaysia as one of the pillars in the curriculum. STEM focuses on teaching and learning based on higher order thinking skills (HOTS), problem-solving, collaborative

learning, project-based learning as well as inquiry- based learning. The Malaysian government committed in ensuring that these curriculums meet the characteristics of STEM implementation.

This is clearly seen in the 'Blue Ocean Strategy' that contained inside Malaysia Education Blueprint 2013-2015(Ismail et.al,2019). To date, little is known about the knowledge and skills in microcontroller and programming courses among lower secondary school students. Therefore, this study aims to explore the level of early exposure to smartphones and computers, knowledge and skills in programming and knowledge and skills in microcontroller among Arau lower secondary school students.

**Advantages of Learning Programming and Microcontroller Courses Among School Students**

Apart from learning RBT and ASK courses in school, students have been exposed to computer programming, code analysis and problem-solving techniques. There are number of studies in the literature revealing that computer programming course has positive effects on the development of different cognitive skills among school students. According to research findings, students who studied computer programming performed better than those who did not in terms of their programming abilities as well as other cognitive abilities like reasoning, metacognition, creative thinking, and arithmetic proficiency (Erümit et al., 2019; Erümit, 2020). Lye and Koh (2014) suggested that programming can expose students to computational thinking. While the scope of computational thinking is debated, Wing (2006) defined it as a fundamental analytical skill that should be learned alongside reading, writing, and mathematics from an early age. Studies proved that learning programming goes beyond a narrow focus of learning programming syntax and develops capabilities to think conceptually and problem- solve at multiple levels of abstraction (Erümit, 2020; Montuori, 2023).

Two methods of computational thinking and two essential abilities that are used in schools to teach and practice computational thinking are computer programming and code writing (Lye & Koh, 2014). They include the skills to create, modify, and evaluate codes and the knowledge about programming concepts and procedures. In school settings, students are commonly taught computational thinking through educational robotics, or virtual coding activities, which both involve programming and coding using technologies or through unplugged coding without the use of technology. The field of educational robotics involves creating a code string or program that instructs a robot to carry out particular tasks or accomplish objectives in a physical setting (Di Lieto et al., 2020).

In Malaysia, educational robotics among school students are taught through microcontroller courses. To enhance higher thinking skills among Malaysian students, educational robotics has good effects on constructivism learning (Felicia & Sharif, 2014; Zainal et al., 2018). In terms of constructivist learning, Bers et.al (2014), presented a constructionist approach to introducing educational robotics in the early childhood classroom. The authors demonstrated how this approach is well suited since the four basic beliefs of constructionism have a longstanding tradition in early childhood education: (a) learning by designing meaningful projects to share in the community, (b) using concrete objects to build and explore the world, (c) the identification of powerful ideas that are both personally and epistemologically significant, (d) the importance of self-reflection as part of the learning process. Studies proved that as educational robotics is applied among school students, it brings good effects and positive changes among the students. Since 2011 onward, researchers have been diligently exploring the application of educational robotics in the preliminary grades of education among school students. The great majority of them examined students sequencing abilities in terms of fundamental science, math, technology, and engineering. In conclusion, educational robotics has a great deal of potential that has to be investigated and applied among Malaysian students. It should also be combined with a curriculum that is appropriate for the region.

## RESEARCH METHODOLOGY

The study was carried out among 50 lower secondary school students in Arau district aged between 13 to 15 years old. The students of the study were chosen by using purposive sampling; with the purpose of representing the lower secondary students' population where age is the key criterion (Ritchie & Lewis, 2014; Rai & Thapa, 2015; Campbell el al, 2020). This is to ensure that all the key populations of relevance to the subject matter are covered. Homogeneous samples were chosen to give a detailed picture of a particular phenomenon, for

example, students who belong to the same population and have similar characteristics. As stated in the previous section, objective of the study is to study the knowledge and skills in programming and microcontroller courses among Arau lower secondary school students.

For this study, a quantitative approach has the potential to provide enough understanding for this study. The selection of this method is due to the reason that the quantitative approach is commonly used when the purpose is to test hypotheses and generalize the results (Hair et al., 2015; Sidel et al;, 2018). Quantitative methods are generally concerned with quantifiable data, usually expressed in numbers and statistics, and associated with large samples, high concern for representativeness, and highly structured methods for data collection (Hair et al., 2015; Mohajan, 2020). A 5-level Likert scale was used in the survey questionnaire. A total of 18 items with 2 sections were used as the instrument in this study to determine the level of knowledge and skills in microcontroller and programming courses among Arau lower secondary school students. Next, the data were gathered to be analyzed. The objective of the analysis is to gain a deeper understanding of the level of knowledge and skills in microcontroller and programming courses among Arau lower secondary school students. Besides, this analysis will summarize the patterns of feedback among students using tables to represent statistical data in visual form. The research approach adopted in this study as shown in Table 1 below:

Table 1: Research approach adopted for this study

| **RESEARCH OBJECTIVE** | **ACTIVITY** | **METHODOLOGY** | **FINDINGS** |
|---|---|---|---|
| **To study the knowledge and skills in microcontroller and programming courses among Arau lower secondary school students** | Identify early exposure to smartphones and computers | Quantitative survey and descriptive analysis | Level of early exposure to smartphones and computers |
| | Identify the level of knowledge and skills in programming | | Level of knowledge and skills in programming |
| | Identify the level of knowledge and | | Level of knowledge and skills in microcontroller |

## ANALYSIS AND DISCUSSION

Based on the data collected, the results have been thoroughly analyzed. As mentioned in the previous section, 50 students were involved in the study. Demographic profile of the students is presented in Table 2.

Table 2: Demographic Profile

| | **DEMOGRAPHIC** | **N** | **%** |
|---|---|---|---|
| **Gender** | | | |
| i | Male | 27 | 54 |

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| | | | |
|---|---|---|---|
| ii | Female | 23 | 46 |
| | **Total** | **50** | **100%** |
| **Age** | | | |
| i | 13 | 0 | 0% |
| ii | 14 | 0 | 0% |
| iii | 15 | 50 | 100% |
| | **Total** | **50** | **100%** |
| **Religion** | | | |
| i | Islam | 50 | 100% |
| ii | Budhha | 0 | 0% |
| iii | Hindu | 0 | 0% |
| iv | Others | 0 | 0% |
| | **Total** | **50** | **100%** |
| **Race** | | | |
| i | Malay | 50 | 100% |
| ii | Chinese | 0 | 0% |
| iii | Indian | 0 | 0% |
| iv | Others | 0 | 0% |
| **Total** | | **50** | **100%** |

Table 2 represents the demographic profiles of the research participants. From the overall population (n=50) based on gender, there are 27 male participants with a percentage of 54% as compared to only 23 female participants with 46%. The second item is assessing on the age of the participants. All participants are from the age of 15 (100%). The third item is assessing on the participant's is religion. All participants are Islam (100%). The last item is to identify the race of the participant. All participants are Malay (100%).

In the next section, it involves three findings which are the: (a) level of early exposure to smartphones and computers, (b) level of knowledge and skills in programming and (c) level of knowledge and skills in microcontroller. The data were gathered using Google Form and then being analyzed using Microsoft Excel as shown in Table 3, Table 4 and Table 5.

**Early Exposure to Smart Phones and Computers**

In the survey, the first component named early exposure using smartphone and computer among respondents in those schools were evaluated. There are four identified items that are associated with the component. These include their ability to have those devices and preference to use the devices for personal use, doing school

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homework and enjoying the entertainment. Table 3 below is the descriptive analysis of the early exposure to smartphone and computers.

Table 3: Early exposure to smartphone/computers

| **QUESTION** | **SCALE** | | | | | | | | | | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **5 - Strongly agree** | | **4 - Agree** | | **3 - Neutral** | | **2 - Disagree** | | **1 - Strongly disagree** | | |
| | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** | |
| **EARLY EXPOSURE TO SMART PHONES/COMPUTERS** | | | | | | | | | | | |
| I am good at using a smartphone/computer | 14 | 28.0% | 24 | 48.0% | 11 | 22.0% | 1 | 2.0% | 0 | 0.0% | 50 |
| I have a smartphone/computer for personal use | 29 | 58.0% | 14 | 28.0% | 5 | 10.0% | 2 | 4.0% | 0 | 0.0% | 50 |
| I use a smartphone/computer to complete school assignments | 19 | 38.0% | 20 | 40.0% | 9 | 18.0% | 2 | 4.0% | 0 | 0.0% | 50 |
| I use a smartphone/computer for entertainment purposes | 12 | 24.0% | 8 | 16.0% | 22 | 44.0% | 7 | 14.0% | 1 | 2.0% | 50 |

From the data, we have concluded that about 76**%** (38) out of 50 respondents strongly agree and agree that they were very good at using smartphones/computers. At least 22% opted for unbiased (neutral) use of smartphones and computers while 2% (1) was not good. Meanwhile, almost a third quarter of respondents (86%) owned a smartphone and computer for personnel use while another 4% (2) do not have those devices. Apart from that, 78% (39) of respondents use that technology to complete their school assignment while 40% (20) of respondents slightly love to spend their time for entertainment purposes. Figure 1 below shows visualization of the respondents.

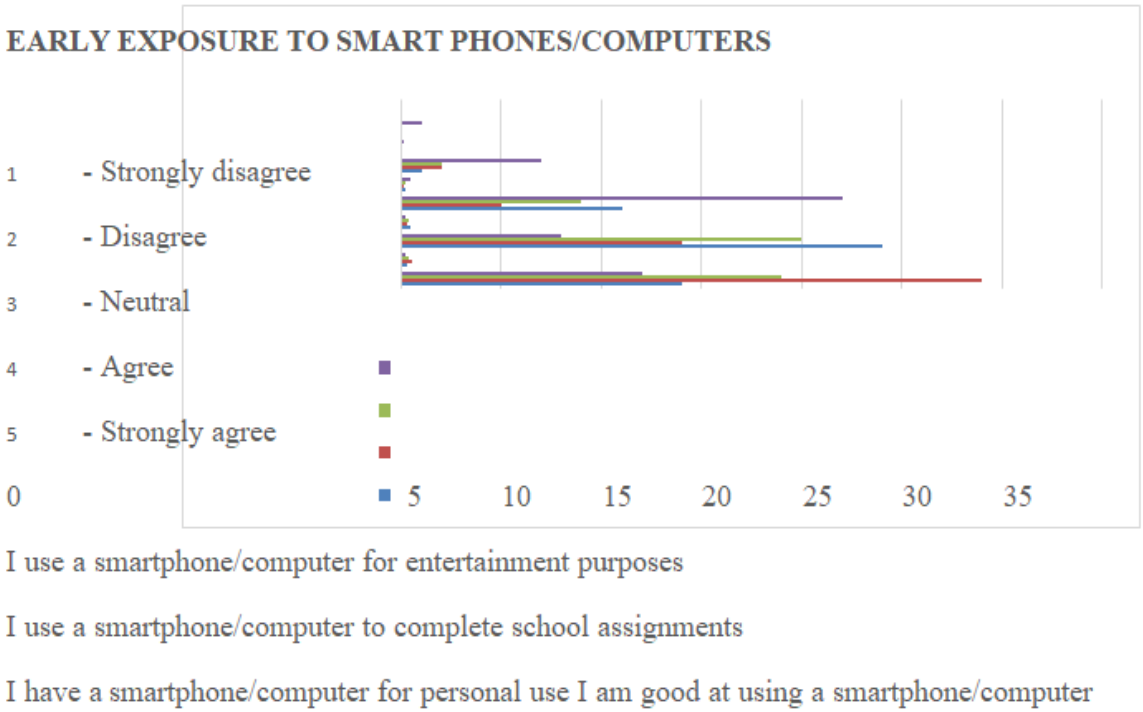


Figure 1: Chart on early exposure to smart phones and computers

**Knowledge and Skill of Programming**

Knowledge and skill of programming is essential for the development of microcontroller projects. There are five identified items that are associated with the knowledge and skill of programming. The opinion of the students regarding their basic knowledge of programming is tested by its correlation to identify the significant relationship to another four items which are the ability to analyze a problem, the ability to design a solution, and the ability to produce simple programming. Table 4 below is the descriptive analysis of the knowledge and skill of programming.

Table 4: Knowledge and Skill of Programming

| **QUESTION** | **SCALE** | | | | | | | | | | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **5 - Strongly agree** | | **4 - Agree** | | **3 - Neutral** | | **2 - Disagree** | | **1 - Strongly disagree** | | |
| | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** | |
| **KNOWLEDGE AND SKILL OF PROGRAMMING** | | | | | | | | | | | |
| I have basic knowledge of programming | 3 | 6.0% | 13 | 26.0 % | 28 | 56.0 % | 3 | 6.0% | 3 | 6.0% | 50 |
| I can analyze a problem related to programming (example: input, | 1 | 2.0% | 16 | 32.0 % | 24 | 48.0 % | 7 | 14.0 % | 2 | 4.0% | 50 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| output and process) | | | | | | | | | | | |
| I can design a solution to a programming-related problem (example: algorithm, flowchart) | 4 | 8.0% | 4 | 8.0% | 30 | 60.0 % | 10 | 20.0 % | 2 | 4.0% | 50 |
| I can produce simple programming related to problems that required programming problem | 1 | 2.0% | 16 | 32.7 % | 24 | 49.0 % | 6 | 12.2 % | 2 | 4.1% | 49 |
| I used to write program for assignments and projects | 7 | 14.3 % | 19 | 38.8 % | 15 | 30.6 % | 6 | 12.2 % | 2 | 4.1% | 49 |

Regarding the finding for Table 4, only 32% (16) out of 50 respondents strongly agree and agree that they have basic knowledge in programming. Meanwhile almost more than half or 56% (28) respondents posed neutral opinions about their knowledge and skills in programming. Surprisingly, 12% (6) students opted to disagree and strongly disagree about their basic knowledge of programming despite all selected respondents having taken RBT and ASK subjects during the school year. This outcome is consistent with the behavior of the respondents when its correlation is tested with the items fundamental to programming which are the ability to analyze problems (0.789), the ability to design solutions (0.826), and the ability to produce programs (0.612). Further study may be worthwhile in order to investigate the effectiveness of RBT and ASK subjects taught in the school though 53.1% (26) students used to write programs for assignments and projects. Figure 2 below visualize the data of the respondents.

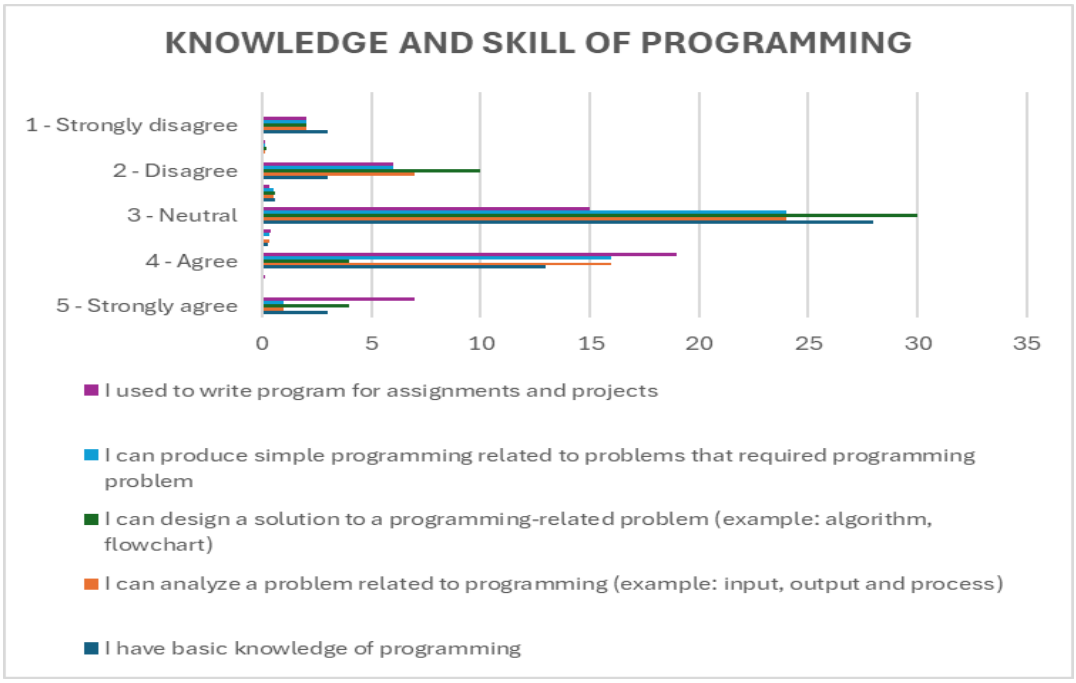


Figure 2: Chart on knowledge and skill of programming

**Knowledge and Skill of Microcontroller**

Knowledge and skill of microcontroller is another important component required by the students to know towards the development of microcontroller projects. There are five identified items that are associated with the knowledge and skill of microcontrollers. Table 5 below is the descriptive analysis of the knowledge and skill of microcontrollers.

Table 5: Knowledge and Skill of Programming

| QUESTION | SCALE | | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 - Strongly agree | | 4 - Agree | | 3 - Neutral | | 2 - Disagree | | 1 - Strongly disagree | | |
| | N | % | N | % | N | % | N | % | N | % | |
| **KNOWLEDGE AND SKILL OF MICROCONTROLLER** | | | | | | | | | | | |
| I know the basic components of microcontroller (example: input, output) | 4 | 8.0% | 16 | 32.0 % | 23 | 46.0 % | 7 | 14.0 % | 0 | 0.0% | 50 |
| I know the microcontroller board | 12 | 24.0 % | 7 | 14.0 % | 18 | 36.0 % | 12 | 24.0 % | 1 | 2.0% | 50 |
| I know the benefits of using microcontroller in a assignment or project | 3 | 6.1% | 8 | 16.3 % | 25 | 51.0 % | 13 | 26.5 % | 0 | 0.0% | 49 |
| I've seen (in person or online) microcontroller related assignments or projects | 13 | 26.5 % | 15 | 30.6 % | 7 | 14.3 % | 14 | 28.6 % | 0 | 0.0% | 49 |
| I used to apply microcontroller for assignments and projects | 8 | 16.3 % | 8 | 16.3 % | 12 | 24.5 % | 16 | 32.7 % | 5 | 10.2 % | 49 |

Based on the above table, only 40% (20) of the students strongly agree and agree that they know the basic components of microcontrollers. This outcome almost aligned with 38%

(19) of the respondents strongly agreeing and agreeing that they know the microcontroller board. However this finding is considered low while all selected respondents having taken RBT and ASK subjects during the school year. Although 67.1% (28) respondents strongly agree and agree that they have seen in person or online microcontroller related assignments or projects but they seem to still not be able to understand the potential benefits of using a microcontroller where 77.5% (38) responded neutral, disagree, and disagree that they know the benefit it in assignment or project. Figure 3 below visualized the data from respondents.

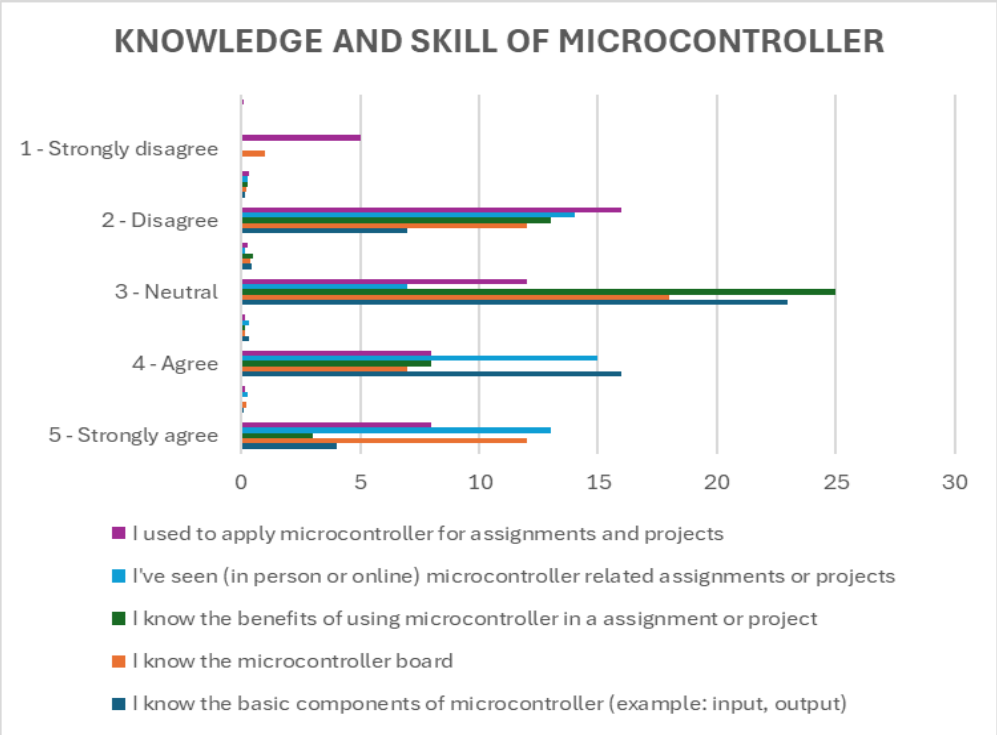


Figure 3: Chart on knowledge and skill of microcontroller

To summarize the findings, most of students opted for neutral decision in section (b) and (c) as they are still newbie for the subject in their school. However, they might be more attracted to subject if there is more exposure and push factor in learning STEM.

## CONCLUSION

The study on the knowledge and skills in programming and microcontroller courses among Arau lower secondary school students reveals that a majority of students were exposed to the use of a computing device from an early age where more than 75% used such devices to complete school assignments. However, despite being taught either RBT or ASK subjects, a high percentage of students claim that they lack the basic knowledge of programming and are still not be able to understand the potential benefits of using a microcontroller. These findings call for further study on the effectiveness of teaching RBT and ASK subjects in schools. In addition, increasing efforts to raise awareness on the importance of STEM as well as providing more opportunities for all students from various background to participate in STEM activities need be carried out in order to shape a generation that can navigate and excels in today's technology-driven world.

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## CONFLICT OF INTEREST

None declared.

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