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Awareness of Science, Technology, Engineering & Mathematics (STEM) Education among Primary & Secondary School Students in Pulau Pinang, Malaysia

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Abstract

STEM has become the main agenda in Malaysian Education to boost students' awareness about the importance of Science and Mathematics. As reported by the statistics from the Ministry of Education, the current percentage of students who have chosen Science and Technology as their own career path has significantly dropped. This situation is quite worrying since the vision of Malaysia to become a developed country or industrialized country cannot be achieved if the majority of Malaysians are not interested in STEM. Suppose this situation continuously happens, and nothing is done to solve it. In that case, the implication is that the government will have to depend on experts from other countries to fulfill the demands of local and global industries. Based on the yearly budget presented by the Prime Minister of Malaysia, almost 20% has been given to the Ministry of Education, and almost 100 million of it has been allocated for the empowerment of STEM. Therefore, youngsters must be seriously encouraged and motivated to promote their interest in STEM. This present paper discusses the level of students' interest in STEM during a STEM exposition or carnival conducted by an education institution, which was held in 2023 at Pulau Pinang, Malaysia. A total of 76 students answered the questions. The students involved were primary and secondary school students from Sekolah Kebangsaan (SK), Sekolah Jenis Kebangsaan Cina (SJKC), Sekolah Jenis Kebangsaan Tamil (SJKT), Sekolah Menengah Kebangsaan (SMK) and Sekolah Menengah Kebangsaan Jenis Cina (SMKJC). Data were analyzed using descriptive statistics. The focus of this study was on the primary and secondary school students, whether they are interested in answering simple questions and their ability to get correct answers through their skills and knowledge of STEM. From the observations conducted, it was apparent that the students were very eager and enthusiastic to answer the questions. In addition, positive reactions were observed among students after answering the questions given, with each of them being awarded simple gifts as an appreciation. Findings from this study indicated that students in primary schools perform better in mathematics and technology than those in secondary

school. This research may help teachers concentrate on specific topics to enhance students' interest in STEM fields.
Keywords: STEM, Primary School, Secondary School, Descriptive Statistics, Students.

Introduction

As defined by Reeve (2014), STEM consists of four main elements, namely Science, Technology, Engineering and Mathematics. Science focuses on nature, while technology is concerned with innovating new tools to change nature to fulfill societies and global demands. The field of engineering requires science and mathematics to produce new technology. Mathematics uses numbers, patterns, and symbolic formulas as a significant relationship to science, engineering and technology. Whatever the definition is, the ultimate goal of STEM in education is to prepare students for the needs of global industrialization and continuously develop their awareness about the importance of science (Halim, 2018). Awareness has been given to the students since primary school regarding the importance of STEM education in producing more highly skilled labor to support Malaysian economic growth. This effort gives early exposure to the youth in STEM and slowly develops the scientific knowledge and consciousness for their future career demands.

With the emphasis on STEM in education systems, the Ministry of Education (MOE) Malaysia has introduced STEM as one of the pillars in the new curriculum, as stated in the National Education Blueprint (PPPM) 2013-2025. The blueprint provides a comprehensive framework to reform the current education system, stressing improving student skills and knowledge while also preparing them for challenges in the 21st century (OECD, 2020). Motivation should be given to the students from primary school to allow the consistency of their career choices, especially in the field of STEM education (Duschl, 2019). The motivation can be given by experts from the industries or educators from tertiary education institutions to the youngsters during the career development expositions, which is the best platform for the unity of students' knowledge and preparation in the STEM industry sector (Razali et al., 2020).

STEM not only stresses the aspect of theory but combines concepts of four disciplines of theory to solve real problems through the ability of critical thinking, problem-solving and teamwork (National Science Foundation, 2020). In addition, as mentioned by Han et al. (2014), STEM enables students to create rich innovations and engaging learning experiences that foster their critical thinking, problem-solving, collaboration work, and mature thinking. STEM education is not only about teaching students a subject and preparing them for specific careers but also about giving students the tools to invent innovative products or better-quality service process flows to solve real problems.

STEM and Industrial Revolution (IR) 4.0 are interrelated each other. The future of the world depends on the growth and knowledge development of artificial intelligence (AI), cloud computing, big data analytics and the Internet of Things. The industry must get ready to shift the production power from humans to intelligent machines or robots (Kolandan, 2019). More technology will be innovated to accommodate the current needs of the young generation. IR 4.0 is believed to be able to improve the Malaysian economy to be equal with other developed countries. Hence, to ensure that IR 4.0 is successfully implemented, the government should force the affected ministries, such as the Education (MOE) and Science, Technology & Innovation (MOSTI), to strengthen the youngsters, especially in primary and secondary schools, to choose STEM as their future career path. It can be done through the promotion during the STEM exposition or STEM innovation exhibition.

This article discusses the aspects of students' interest and their awareness of STEM education, especially among students from primary and secondary schools during the STEM exposition conducted in Pulau Pinang. The following section presents the literature review on STEM education awareness among students. The next part explains the methodology and tools used for data collection in more detail. The subsequent section presents the data analysis correlated with the discussion of the findings. Finally, the overall conclusion is presented in the final section.

Literature Review

The 21st century has brought Malaysia various challenges in the development of communication technology. STEM was applied in Malaysia's education systems as a method to develop the country, produce highly skilled and knowledgeable workers, and fulfill the current demands of a STEM-driven economy (Aspin et al., 2022). Therefore, education has been playing an important role in implementing STEM education since primary school to produce competitive students to face the challenges of Industrial Revolution (IR) 4.0. Cultivating students' interest in STEM education is crucial, and the critical part is to produce workers who can apply and manage science and technology to solve real problems, improve production and be recognized by world-class industries (Vennix et al., 2018).

Khairani (2017) mentioned three actions to increase the student's interest in STEM. The first strategy is to improve students' learning styles in the curriculum of each STEM subject and strengthen the curriculum to enhance their interest. Exposure to real case problems with higher-order thinking skills (HOTS) capabilities in science and mathematics subjects and integration of the relevant topic of the subjects should be utilized. The second strategy is to focus on the educators; relevant ongoing training should be given to improve their skills and competencies in STEM education. Educators should be competent and skillful in modeling innovative design learning that is attractive and fun for the students so that the learning objectives can be achieved. The third strategy is to encourage parents to promote the importance of science and mathematics areas to their kids for the future demands of the country.

The education minister, Fadhlina Sidek, has reported that the percentage of students enrolled in the science, technology, engineering and mathematics (STEM) stream has increased from 40.95% in 2021 to 45.73% in 2023 (The Malaysian Reserve, 2023). This has shown that the strategy is effective, and more effort should be given to increase the figure by 60% by the year 2030 in preparation for Malaysia to be a developed country parallel with Singapore, Japan and China. STEM education is important because, according to the World Economic Forum (2020), the most demanding job specialization by the year 2025 will be related to STEM fields such as data analysts, robotics engineers, artificial intelligence (AI) and Internet of Things (IoT) experts. Hence, the Ministry of Education and other related authorities should design a comprehensive strategy to facilitate STEM education from the primary school stage in preparing for the world modernization era.

The education policy makers in STEM education must make sure that the curriculum design is interesting and exciting enough. An integrated approach by combining science, technology, engineering and mathematics will increase student interest, especially in the early stage of learning development (Winarni et al., 2016). The elements of STEM will not be taught as separate subjects but will be embedded as the appropriate solution in the problem statements (Angraini & Huzaifah, 2017). The following Figure 1 illustrates the pattern of integrating or overlapping different elements of STEM education.

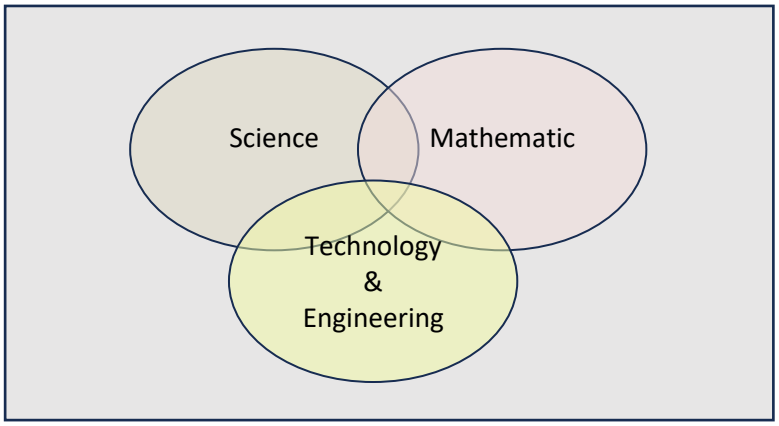

Figure 1: Integrating or overlapping different elements of STEM

STEM education prioritizes the concepts introduced by the 4C components, namely communication, collaboration, creativity, and critical thinking (Lah, 2018). In STEM education, students have to learn how to collaborate and participate through Problem-Based Learning (PBL) and problem-solving processes, as shown in Figure 2. The learning experience is important for preparing the students to face future challenges and demands as part of a competing workforce (Ng, 2016).

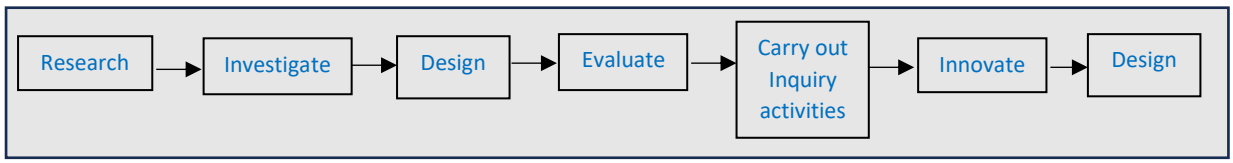

Figure 2: Problem-solving Process (Ng, 2016)

The government has introduced several campaigns and initiatives to promote STEM education with the ultimate goal of ensuring that all Malaysians are aware of STEM education. The Ministry of Education should encourage each school to organize special STEM activities, STEM expositions or related clubs handling a program to inspire students to enroll in the science stream. The same initiative or program should be extended the STEM education to students in rural areas, B40 families and those with special needs (Bernama, 2019). According to Palmer, Burke, and Aubusson (2017), based on their several studies and observations, it was discovered that the advice from parents, teachers and peers does not significantly or relatively affect the student's decision on course selection. Instead, the students ranked enjoyment of the course, interest, ability and demands for future careers as the most important factors. Without encouragement or adequate knowledge about the educational and career opportunities in STEM programs, there is a risk that students will dismiss a STEM-based career path as a potential option for their future (Blotnicky et al., 2018).

Methodology

This research was conducted at Universiti Teknologi Mara (UiTM) Pulau Pinang Branch at Permatang Pauh Campus on 13 September 2023 during the Pulau Pinang, Malaysia STEM Carnival 2023.

Figure 3: The respondents who participated in the carnival

The data of this study were collected from the students as respondents who participated in the carnival. The respondents were specifically divided into two groups. The first group consisted of primary school students from Standard 4 to Standard 6. Meanwhile, the second group comprised secondary school students from Form 1 to Form 3 only. The research design employed in this study was descriptive and observative. The perceptions of students who responded to the survey looked appealing, exciting, fascinating and encouraging. The data was gathered at a specific time and location from the respondents during the carnival day only (Hall, 2008).

Two sets of question papers were constructed and distributed to the students while they were visiting the carnival booth (Appendices A1 and A2). Systematic Random Sampling was applied, which involved four sheets of question sets randomly distributed to every 10 students. The students were given ample time to answer either Set A or Set B, depending on their school levels (such as primary or secondary schools). Every set consisted of three mathematics questions and one question on technology knowledge. The three mathematics questions measure their ability and creativity to solve the higher-order thinking skills (HOTS) questions. In contrast, the fourth question identifies whether the students are observed on the logo.

Once finished, they were given a special gift for their willingness to answer the questions. The students who did not have a chance to answer the question were given an opportunity to play mathematics and computer games available at the booths. A total of 41 respondents from primary schools and 35 from secondary schools successfully responded.

This study also utilized the observation method. The students' attitudes, behaviors and reflections were observed during the process of answering the questions.

Result & Discussion

The first part of the analysis was a descriptive statistic. Based on descriptive statistics in Table 1, 39 respondents were male, while 37 were female. Out of a total of 76 students, 23 of them were from Sekolah Kebangsaan (SK), 12 students were from Sekolah Jenis Kebangsaan Cina (SJKC), 6 students were from Sekolah Jenis Kebangsaan Tamil (SJKT), 16 students were from Sekolah Menengah Kebangsaan (SMK) and the remaining students were from Sekolah Menengah Kebangsaan Jenis Cina (SMKJC).

Table 1
Descriptive Data

		Gender		Total
		Male	*Female*	
School Type	*SK*	14	9	**23**
	SJKC	3	9	**12**
	SJKT	6	0	**6**
	SMK	9	10	**19**
	SMKJC	7	9	**16**
Total		**39**	**37**	**76**

Figure 4 shows a bar chart of the percentage of students by gender. Based on this bar chart, it was found that more female students answered the questions when compared to male students except for Sekolah Kebangsaan (SK), 11.8% for females and 18.4% for males. For Sekolah Jenis Kebangsaan Tamil (SJKT), no female student answered the question.

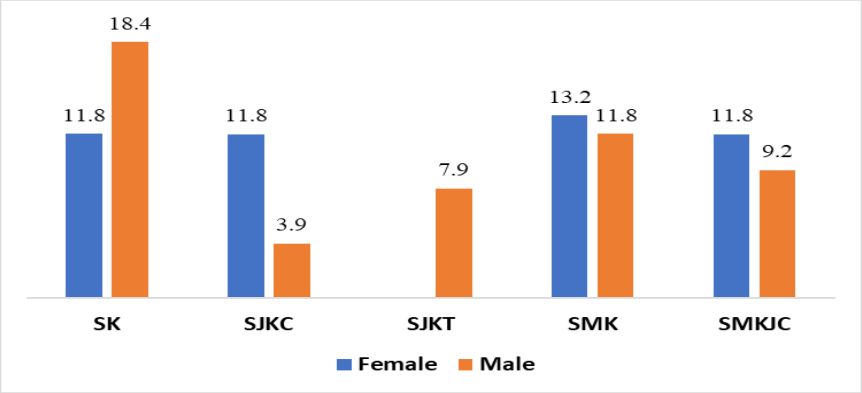

Figure 4: Percentage of students by gender

The scores for mathematics and technology knowledge questions were used in the following analysis. The full score for mathematics is 3 marks, whereas the full score for technology knowledge is 1 mark. Figure 5 displays the score for mathematics and technology knowledge by school type. It was discovered that the results for mathematics and technological knowledge in primary schools were fairly satisfactory. In comparison to SMK, which received a low score of 0.11, SMKJC students had a higher mean score of 0.88 points for technology knowledge questions. Both SMK and SMKJC schools have relatively poor mathematics questions, with an average of 1 mark out of a possible 3 points.

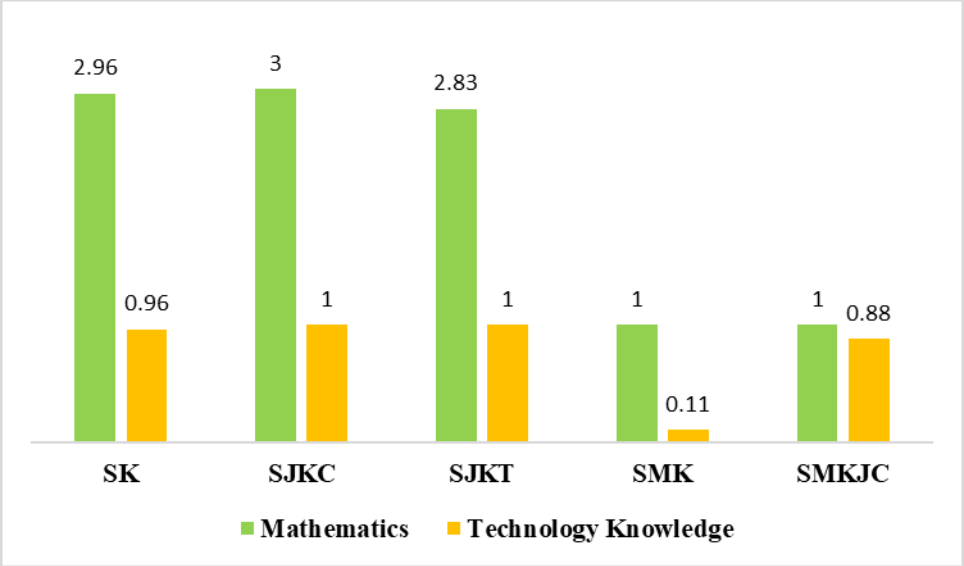

Figure 5: Scores for Mathematics and Technology Knowledge by School Type

The graphs in Figure 6 and Figure 7 present a detailed representation of the percentage scores for mathematics and technology knowledge. Here, performance in the queried field can be more clearly observed as the scores are presented in the percentage form.

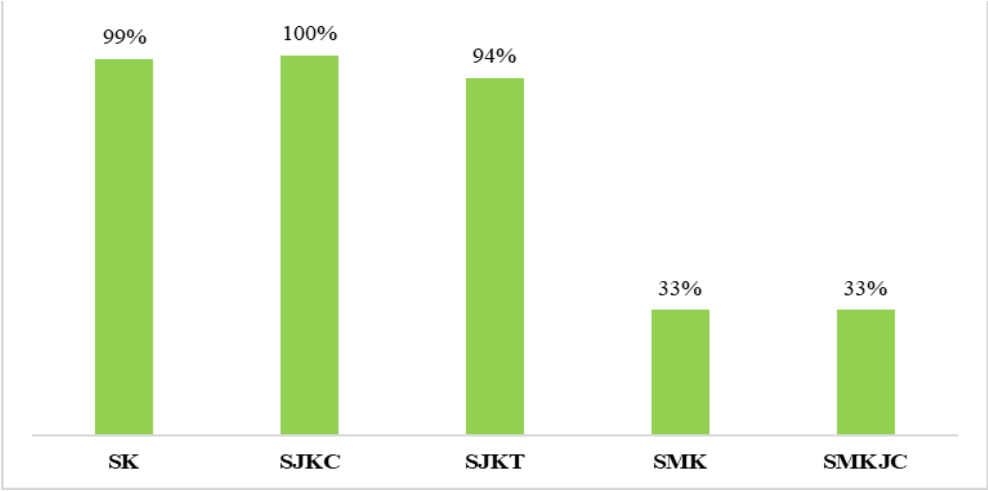

Figure 6: Percentage Score (Mathematics)

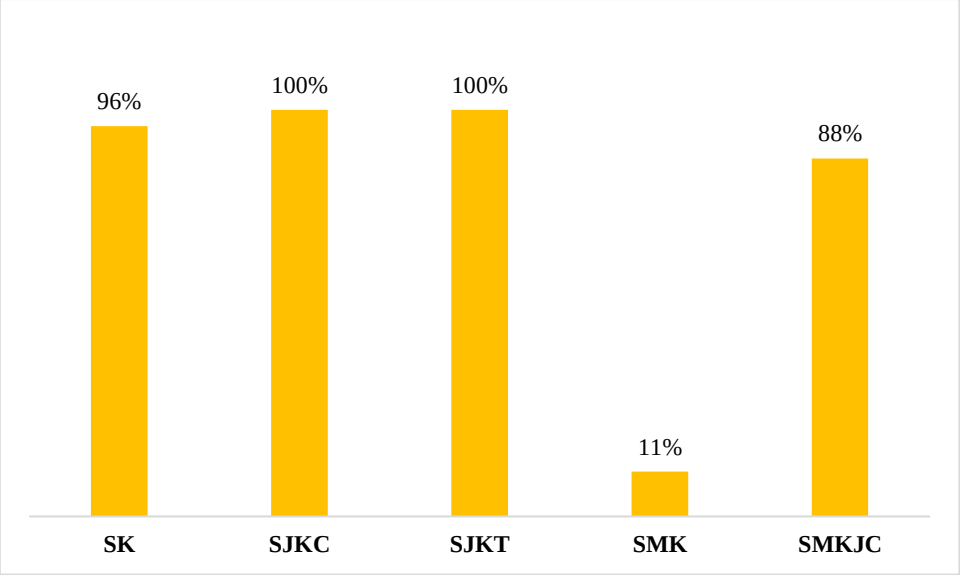

Figure 7: Percentage Score (Technology Knowledge)

Figure 8 shows the scores obtained when answering questions by gender. For questions involving technology knowledge, male and female students performed equally. Furthermore, male and female pupils performed while answering mathematics questions. Both genders received relatively moderate scores, with 2.13 (males) and 1.97 (females), respectively, on the mathematics question. On the technology knowledge question, however, they received scores of 0.72 (males) and 0.76 (females).

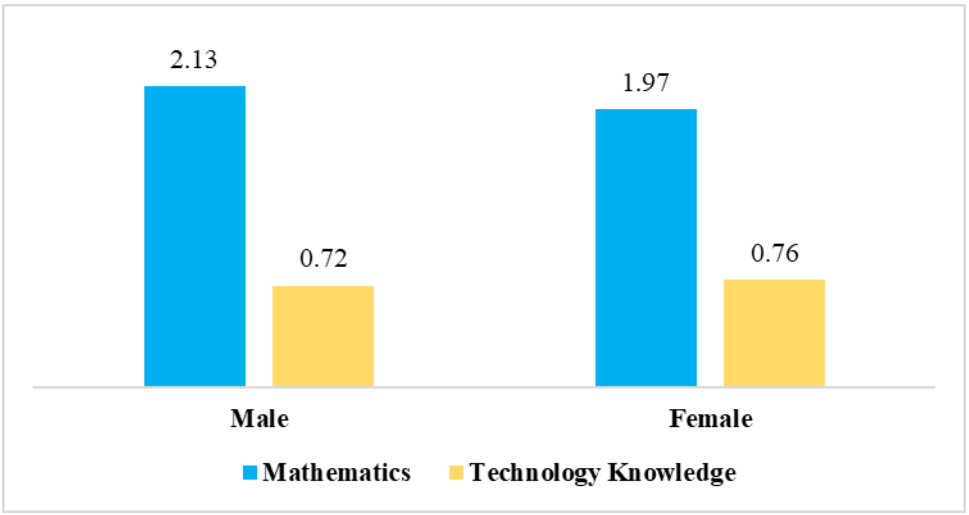

Figure 8: Scores for Mathematics and Technology Knowledge by Gender

Figure 9 represents the continuation of the previous diagram. This figure illustrates the scores in percentages, enhancing the ease of evaluating the score visuals.

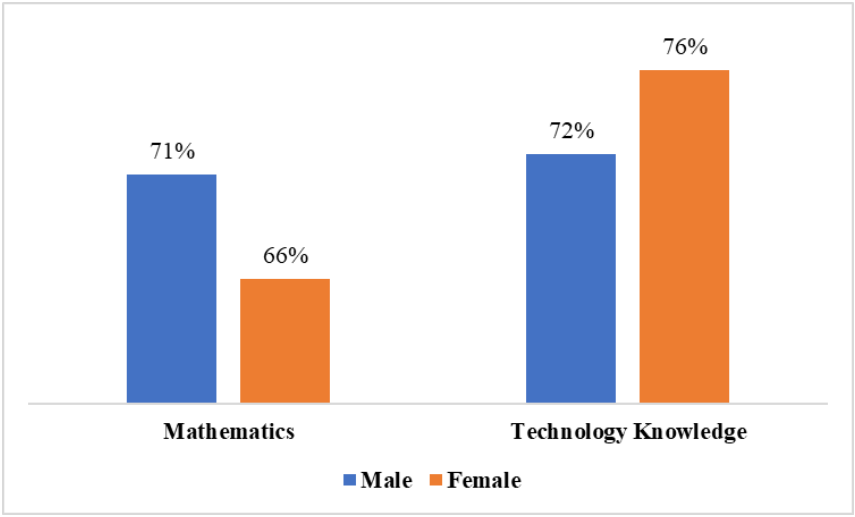

Figure 9: Percentage Scores for Mathematics and Technology Knowledge by Gender

Figure 10 displays the graph of students' response time to the questions about their understanding of technology knowledge and mathematics questions. The most intriguing part of this graph is that primary school kids responded faster than secondary school students. This may be due to the questions being quite challenging for secondary school students when compared to primary school students. In primary schools, SJKC (3.33 minutes) pupils outperformed SK (4.04 minutes) and SJKT (4.17 minutes) in answering questions. Students in secondary schools have roughly the same amount of time: 8.16 minutes for SMK and 8.13 minutes for SMKJC.

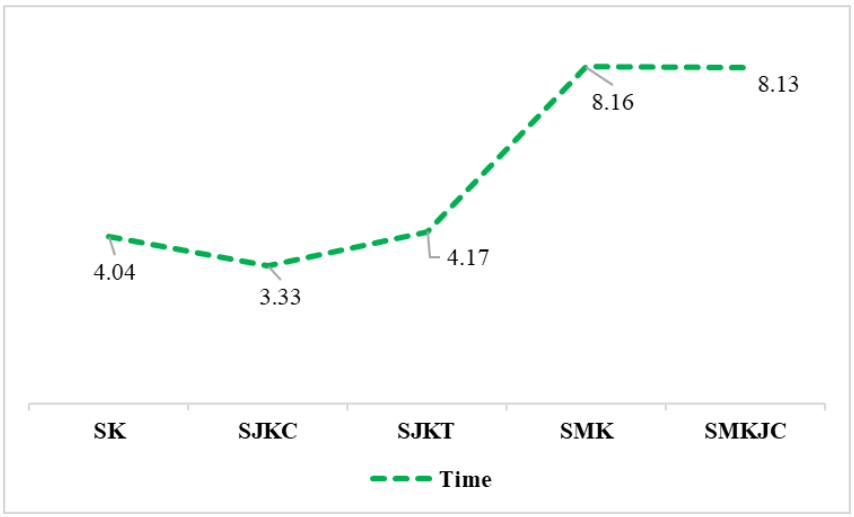

Figure 10: Students' Response Time (in minutes)

Through the observation, it was discovered that most of the students were excited and enthusiastic to answer the questions. Many students wanted to volunteer, but the question sets were distributed to only four students for every 10 visitors. The majority of the students preferred to discuss the questions to understand the meaning of the questions. Question sets distributed to primary school students were answered quicker compared to secondary school set questions. Based on the students' responses, the questions were a bit challenging for the secondary school.

Furthermore, it was demonstrated that most of the students were trying to search or google the answers. Nevertheless, the answers cannot be found or retrieved from the web as the questions were newly constructed for the STEM carnival. According to Renderee and Mon (2011), the students were familiar with the Google platform to search resources using keywords and advanced information searching.

Conclusion

The research findings indicated that primary school students' achievement was better than those from secondary school in technology and mathematics knowledge. Among the different school types, SJKC students achieved the highest scores, surpassing SK and SJKT. Notably, all SJKC students successfully answered the questions without errors, setting a commendable example for other schools to emulate. This underscores the importance of providing students with increased exposure to foster a keen interest in Science, Technology, Engineering, and Mathematics (STEM). As a notable initiative, MOSTI recently organized the "Malaysia Techlympic," showcasing the potential for promoting STEM education. Nevertheless, achieving this objective requires close collaboration between teachers and students.

Considering the mean analysis indicating low performance in mathematics for secondary schools, there is a pressing need to prioritize STEM education. Implementing a STEM carnival emerges as a strategic initiative to boost students' interest in the field. This carnival seeks to inspire creative thinking and encourages students to generate ideas and solutions under the guidance of teachers serving as mentors. Moreover, the program holds the potential to enhance student learning through engaging and practical activities. Various stations featuring science experiments, robotics competitions, invention showcases, and demonstrations of cutting-edge technology offer students a diverse and immersive learning experience. It is hoped that this research will guide educators to focus on issues that need serious attention to enhance students' interest in STEM fields and address the challenges, particularly in mathematics and technology knowledge.

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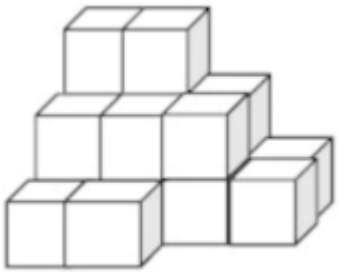
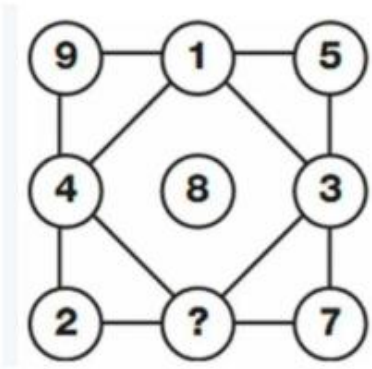
Appendix A1

(Primary School Set)

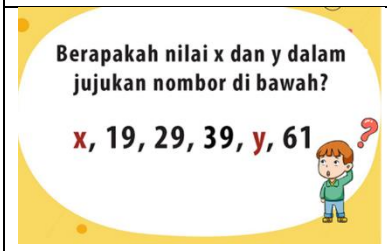
QUESTION	YOUR ANSWER
 Count how many cubes of the above diagram.	
Count how many times 7 comes between 0 to 100.	
 Determine an appropriate number for **?**	

 This is the symbol for …. ?	

Answer : 18; 20; 6; android

Appendix A2

(Secondary School Set)

QUESTION	YOUR ANSWER
 What is the value of X and Y respectively?	
 What is the value for X and Y respectively for the above sequence?	
 What is the missing number?	
 This is the symbol of ….. ?	

Answer : X=8, Y=17; X=10, Y=51;5;WhatsApp