

RESEARCH REPORT

THE IMPACT OF STEM ACTIVITIES ON SCHOOL STUDENTS' MOTIVATION TO PURSUE STUDIES IN STEM-RELATED FIELDS: A STUDY IN DUN N8 SATOK



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A STUDY IN DUN N8 SATOK

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PREFACE



This research report represents a collaborative effort to understand and enhance the role of STEM education in shaping the future of our youth. The study was conducted with the aim of providing empirical insights into how STEM activities influence students' motivation and aspirations, and to develop a framework for strengthening STEM participation, particularly in the Satok Constituency.

The successful completion of this research would not have been possible without the generous support and commitment of several key individuals and organizations. First and foremost, we extend our deepest gratitude to Yang Berhormat Dato Haji Ibrahim bin Haji Baki, whose vision and financial support through the Biro Pendidikan DUN N8 Satok made this project a reality. We also extend our gratitude to Tn Hj. Abdul Samat Gany whose support and insights have been instrumental in enabling this important work.

We also wish to acknowledge the Kementerian Pendidikan Malaysia, Jabatan Pendidikan Negeri Sarawak for their approval, facilitation, and steadfast support throughout the research process. The cooperation of the principals, STEM teachers, and students from the five participating schools, namely SK Combined, SK Rakyat Haji Bolhassan, SK Merpati Jepang, SMK Batu Kawa, and SMK St. Joseph was invaluable. Their openness, enthusiasm, and willingness to share your experiences greatly enriched the study. Our profound gratitude to the management of Universiti Teknologi MARA (UiTM) Sarawak Branch, for their guidance, administrative assistance, and collaborative spirit from the inception to the completion of this project.

The dedication shown and expertise provided by members of this wonderful research team have been the cornerstone of this report. We hope that the findings and recommendations presented herein will serve as a valuable resource for educators, policymakers, and all stakeholders committed to nurturing a future-ready generation through STEM education.

Dr. Abang Fhaeizdhyall Abang Madaud

Principal Investigator

EXECUTIVE SUMMARY

This research investigates the impact of ongoing Science, Technology, Engineering, and Mathematics (STEM) activities on student motivation and enrolment intent within the DUN N8 Satok constituency in Sarawak. Addressing the national decline in STEM interest, this study aligns with Sarawak's Post-COVID-19 Development Strategy (PCDS) 2030, which emphasizes the necessity of a highly skilled, future-ready workforce. Employing a mixed-methods design, the study gathered quantitative and qualitative data from 78 primary and secondary students alongside 10 STEM teachers across five local schools.

The findings provide compelling evidence that STEM activities significantly enhance student motivation. For primary students, interactive, hands-on, and technology-integrated experiences markedly increased excitement and comprehension in Science and Mathematics. Similarly, secondary students indicated that practical STEM engagements, coupled with strong parental encouragement and clear career prospects, directly inspired their intent to pursue science stream education. Teachers corroborated these outcomes, emphasizing that real-world applications and external collaborations, such as university-led STEM carnivals, are highly effective tools for boosting student engagement.

Despite these positive outcomes, the implementation of school-level STEM programs is currently hindered by critical barriers, including inadequate financial resources, limited access to digital tools, and a lack of specialized technical training for teachers. To overcome these challenges, this report proposes a strategic five-pillar framework encompassing program content design, structural and administrative support, teacher professional development, stakeholder mobilization, and assessment accountability. Ultimately, sustaining long-term STEM participation requires equitable resource distribution, enhanced educator competencies, and robust community collaboration. The findings of this research is published in the Asian Journal of Social Science Research in June 2026.

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1.1 ABOUT DUN N8 SATOK

DUN N8 Satok stands as one of Sarawak's most politically significant constituencies, serving as a historic urban stronghold for the Gabungan Parti Sarawak (GPS) coalition. For over four decades, the seat was synonymous with the leadership of Datuk Patinggi Abang Johari Openg, the current Premier of Sarawak, before being handed over to Datuk Ibrahim Baki in 2021. This transition maintained the seat's status as a pillar of the Parti Pesaka Bumiputera Bersatu (PBB), characterized by high voter loyalty and a reputation for political stability that bridges traditional grassroots support with modern governance.

Demographically, Satok is a vibrant Malay-majority urban enclave that preserves the unique heritage of Kuching's traditional villages, such as Kampung Bandarsah and Kampung Masjid. Despite its deep cultural roots, the constituency is highly modernized and socio-economically diverse, housing a mix of civil servants, professionals, and local entrepreneurs. Its strategic location makes it a vital commercial corridor, reflecting a population that is both culturally grounded and economically progressive.

The Education Bureau within the Satok Service Center plays a pivotal role in the constituency's social development by prioritizing human capital. The Satok Education Fund, which provides financial support in the form of grants to students transitioning into higher education to ease the burden of registration fees. Beyond direct financial aid, the bureau focuses on modernizing local school facilities and promoting STEM and digital literacy programs. These initiatives are designed to ensure that the younger generation in Satok is well-equipped to participate in Sarawak's evolving digital economy and long-term development goals.

1.2 INITIATIVES TOWARDS PROMOTING STEM EDUCATION

The DUN N8 Satok Service Center has placed a significant emphasis on cultivating STEM (Science, Technology, Engineering, and Mathematics) excellence among the youth to prepare them for Sarawak's high-tech future. A primary strategy involves hosting large-scale STEM Carnivals, such as the major event held at SK Merpati Jepang, which attracted thousands of participants. These carnivals are designed to be highly interactive, offering students hands-on exposure to robotics, coding, and scientific experiments to spark curiosity and interest in technical fields from a young age.

In addition to outreach events, the constituency focuses on providing the physical infrastructure necessary for modern learning through specialized facilities. SK Rakyat Haji Bolhassan serves as a landmark for this initiative, having been selected as one of the pilot schools in Sarawak to host a dedicated STEM Education Lab. This lab provides students with access to digital tools and equipment that are often unavailable in standard classrooms, ensuring that the theoretical knowledge gained in school is reinforced with practical, technology-driven applications.

The Satok Education Bureau ensures that these educational goals are supported by financial incentives and career alignment. The Dana Pendidikan Satok (Satok Education Fund) prioritizes financial grants for students entering tertiary education, particularly those pursuing STEM-related degrees in public universities. By easing the financial burden of registration and related costs, the service center encourages local students to specialize in technical sectors that directly support Sarawak's Post-COVID-19 Development Strategy (PCDS 2030) and the state's growing digital economy.

1.3 STEM IN GENERAL

STEM education originated in the United States. Initially termed "SMET," representing Science, Mathematics, Engineering, and Technology, the acronym was later revised to "STEM" by the National Science Foundation in the 1990s to highlight the significance of these four disciplines (Sanders, 2009). Early STEM initiatives primarily focused on strengthening science and mathematics as separate subjects, with limited integration of engineering and technology (Breiner, Harkness Johnson, & Koehler, 2012). Learning these subjects in isolation

often reduced students' interest, as they were unable to see connections among disciplines or relate concepts to real-world contexts (Kelly & Knowles, 2016).

Consequently, researchers in the United States began promoting an integrated STEM approach. Evidence indicates that integrated STEM enhances learning by making it more meaningful, coherent, and engaging for students (National Research Council [NRC], 2012; Kelley & Knowles, 2016). This is significant because the learning experience influences academic achievement, motivation to pursue further education, and persistence in STEM-related careers (Marginson, Tytler, Freeman, & Roberts, 2013). The student-centred nature of integrated STEM also encourages learners to develop roles such as problem solvers, independent thinkers, innovators, and inventors (Morrison, 2006). During this exploratory process, students naturally apply critical-thinking abilities, including problem solving and creative thinking (Stohlmann, Moore, & Roehrig, 2012). Moreover, integrated STEM provides long-term advantages by preparing students to address complex global challenges such as climate change and food security as they enter the workforce (Stohlmann et al., 2012). By linking classroom learning to authentic real-life applications and professional STEM practices, this approach deepens students' understanding of STEM career pathways and facilitates their transition into STEM professions, thereby contributing to national workforce development (Hyslop, 2010).

Integrated STEM may also help address challenges faced by Malaysian secondary school students. Research shows that many students perceive science subjects—such as Biology, Physics, and Chemistry—as difficult, irrelevant, and uninteresting, leading them to choose the arts stream instead of the pure science stream. Some students also believe that STEM-related career opportunities in Malaysia are limited, reducing their motivation to pursue science. Even among those who initially select the science stream, attrition occurs at the pre-university or undergraduate level due to insufficient cognitive and scientific skills needed for academic success and STEM employment.

1.4 STEM EDUCATION IN SARAWAK

The Sarawak government, through the Economic Planning Unit Sarawak has outlined human capital as one of the strategies towards a sustainable future of the state. Several key innovative initiatives include developing research and commercial capabilities, unleashing the potential of bioresources, exploring the use of microalgae for green fuel, using Internet of Things (IoT) in agriculture, applying geospatial technology in land surveying, and realizing carbon trading potential. These initiatives require capable and knowledgeable individuals who hail from the science stream educations. More importantly, these are the individuals who learned science, technology, engineering and mathematics subjects in schools or STEM.

Science, Technology, Engineering, and Mathematics (STEM) education has become a central priority for many education systems seeking to prepare learners for innovation-driven economies and complex global challenges. In Sarawak, Malaysia, strengthening STEM participation and competency is closely aligned with broader state development agendas that emphasise human capital formation, digital transformation, and future-ready industries. Recent policy directions and educational initiatives demonstrate Sarawak's commitment to cultivating sustained student interest and achievement in STEM from primary school through tertiary education.

At the school level, multiple programmes have been implemented to enhance engagement with STEM learning. For example, the STEM Catalyst initiative delivers mobile exhibitions, interactive demonstrations, and hands-on activities to schools across the state, reaching more than 6,000 primary pupils from over 130 schools and aiming to inspire early interest in science and technology learning. Complementary efforts include the distribution of robotics kits to selected primary and secondary schools to develop coding, creativity, collaboration, and problem-solving skills among students (The Borneo Post, 2025). Outreach activities led by higher education institutions, such as workshops and competitions involving secondary school students, further reinforce exposure to scientific inquiry, engineering thinking, and digital innovation (Michael & Michael, 2025). Collectively, these initiatives illustrate a systemic approach to building STEM awareness and competencies throughout the schooling continuum.

Beyond early education, Sarawak has also introduced structural policies to expand access to STEM-related tertiary pathways. A state-supported free tertiary education scheme scheduled

to begin in 2026 will cover tuition at selected universities and prioritise programmes aligned with workforce needs, including STEM disciplines. This policy reflects long-term ambitions to increase highly skilled talent and support economic sectors such as the digital and green economies. In parallel, supplementary academic support programmes and community-based STEM literacy projects aim to improve learning outcomes and provide hands-on laboratory experiences that motivate students in science and mathematics.

Science, Technology, Engineering, and Mathematics education has emerged as a critical component of Malaysia's national strategy to enhance workforce skills and drive economic growth in the era of the Fourth Industrial Revolution (Le et al., 2024). Recognizing the importance of cultivating a future-ready workforce, the Malaysian government has implemented various initiatives to strengthen STEM learning across the nation, including the Malaysia Education Blueprint 2013-2025, which aims to boost interest and proficiency in these fields among students and teachers (Idris et al., 2023; Ismail et al., 2019).

In Sarawak specifically, educational stakeholders have identified unique challenges such as low STEM enrolment rates and digital inclusivity gaps affecting rural students, prompting the development of targeted interventions like the Drone Education Program to bridge the divide between digital consumption and digital creation. Despite these national efforts, Malaysia continues to face significant hurdles in meeting the projected demand for 500,000 skilled STEM workers by 2020, with only 45% of students enrolled in science or technical streams in 2014, falling short of the targeted 60:40 Science/Technical to Arts ratio (SIEW, 2017). This persistent shortfall in STEM participation has raised concerns regarding the country's ability to compete effectively in the digital economy, as the supply of talent in these critical fields continues to decline while international assessment scores in TIMSS and PISA remain below global averages (Idris & Bacotang, 2023; Yusof et al., 2021). To address these disparities, educators are increasingly expected to possess dual competencies in both STEM disciplines and creative pedagogies, necessitating comprehensive training programs that align with the demands of Society 5.0 and industrial advancement (Idris & Bacotang, 2023).

Overall, the growing ecosystem of school initiatives, institutional outreach, and supportive public policy highlights Sarawak's strategic effort to strengthen STEM education as a foundation for sustainable development and workforce readiness. Continued research is therefore essential to evaluate the effectiveness of these initiatives and to identify pedagogical

approaches that can further enhance student achievement, engagement, and long-term participation in STEM fields within the Sarawak context.

1.5 BACKGROUND OF STUDY

The Sarawak government, through the Economic Planning Unit Sarawak has outlined human capital as one of the strategies towards a sustainable future of the state. Several key innovative initiatives include developing research and commercial capabilities, unleashing the potential of bioresources, exploring the use of microalgae for green fuel, using Internet of Things (IoT) in agriculture, applying geospatial technology in land surveying, and realizing carbon trading potential. These initiatives require capable and knowledgeable individuals who hail from the science stream education. More importantly, these are the individuals who learned science, technology, engineering and mathematics subjects in schools or STEM.

However, there are issues pertinent to the development of STEM education which include: (1) Students are becoming less interested in pursuing STEM fields in school; (2) There is a worrying trend of decreasing students interests towards STEM education; (3) At the same time, research has shown that STEM education is effective in improving students' learning outcomes, such as academic learning achievement, student motivation, attitude, and problem-solving skills. Research evidence has indicated the many advantages and benefits of STEM programs, which have prompted various agencies to implement STEM programs in schools including the Dewan Undangan Sarawak Constituency of DUN N.8 Satok. However, the effectiveness of such programs on students' motivation towards STEM education is yet to be studied and quantified. Moreover, the challenges and difficulties that exist when implementing such programs are yet to be documented.

The research employed a mixed-method study design which combines quantitative and qualitative research approaches. In the quantitative approach, a set of questionnaires were distributed to the school students and teachers at selected schools within the DUN N.8 Satok constituency. Purposive sampling technique was used to select the schools. The respondents were gathered/identified from those who attended the STEM programs conducted at their schools. Questionnaires and interview protocols were adapted from past studies.

The first phase was to gather information on the perception and inclination of students towards STEM subjects, particularly those students who were in Form 3. This involved the distribution of questionnaires to a sample population of 90 students and 15 STEM teachers. Phase 2 have included the qualitative aspect of the study. This phase was conducted through a series of focus group interviews with at least 10 STEM teachers and 60 school students. They were selected via a voluntarily basis from the schools participated in the first phase of quantitative.

In Phase 3, findings from both phases were consolidated and analyzed, statistically and qualitatively. The outcome would provide insights on the influence of on-going STEM initiatives and also the establishment of a framework, and strategies for the betterment of future STEM activities.

The duration of the research was planned for 12 months. This time frame was ample to successfully carry out the three phases of the research. The outcomes of the research were expected to benefit school students and teachers in N.8 Satok. Furthermore, the relevant agencies and schools might benefit from the findings in terms of enhancing their future STEM initiatives to be conducted in Satok, and Sarawak in general.

Additionally, the findings of this research are expected to be presented in education conferences and published in international journals. Publications of the findings are important as they will contribute to education research and serve as a reference for future studies that may be conducted in Sarawak and internationally. This research can be part of the concentrated effort to uplift the quality of STEM education in Sarawak to meet the Sarawak Innovative Initiatives towards a sustainable future of Sarawak.

1.6 PROBLEM STATEMENT

Students' interest in STEM disciplines has been decreasing day by day (Higde & Aktamis, 2022). For this reason, the improvement of students' interest and approaches to STEM disciplines and the leading students into STEM fields was important. Only in this way, countries could grow individuals who were open to competition for the future, developed in terms of job competencies, keeping up with the age, producing entrepreneurs and innovations (Wang, 2012). Therefore, many countries have been trying to integrate STEM education approach to their curricula in order to educate individuals with knowledge and skills in STEM fields.

As the trend indicates that students are becoming less interested in pursuing STEM fields in school, concerns over student involvement and participation in STEM education at schools are growing. This is made worse by the fact that 72.1 percent of SPM students decide against continuing their education in the future. Due to this circumstance, the nation's capacity to give expertise in STEM and vocational training will not be able to keep up with market demand and the advancement of the Industrial Revolution 4.0. According to a report by the New Straits Times dated March 26, 2024, the Malaysian Prime Minister was quoted saying “The decreasing interest among Malaysian students in Science, Technology, Engineering and Mathematics (STEM) is a worrying trend as there is a decrease in interest among students in STEM”. This has prompted the relevant ministry to take proactive approach to address the matter. In a contrary, research has shown that STEM education is effective in improving students' learning outcomes, such as academic learning achievement, student motivation, attitude, and problem-solving skills (Saraç, 2018; Yildirim, 2016). Nevertheless, there is a decrease in the number of students enrolled in the science stream which is concerning, and this could lead to a severe human capital shortage in the STEM field if the number of students enrolled in STEM courses does not meet the expected standards of 270,000 per year, or 60% of the annual national cohort (Fadzil et al., 2019).

Schools in the DUN N.8 Satok have participated in various STEM programs initiated by various parties. However, the effectiveness of such programs on students' motivation towards STEM education is unknown. Moreover, whether or not challenges and difficulties exist when implementing such programs are yet to be documented. Furthermore, there is no framework that can be made for enhancing STEM programs is available in the body of knowledge that

could enhance the implementation of STEM programs in Satok. Research evidence has indicated the advantages and benefits of STEM programs, which have prompted various agencies to implement STEM programs in schools including the Dewan Undangan Sarawak Constituency of DUN N.8 Satok. However, the effectiveness of such programs on students' motivation towards STEM education is yet to be studied and quantified. Moreover, the challenges and difficulties that exist when implementing such programs are yet to be documented.

1.7 RESEARCH OBJECTIVES

Therefore, based on the current research problem, this research was guided by the following research objectives to address the stated issues:

- (1) To investigate the impact of STEM activities on upper primary school students' motivational beliefs about science subjects.
- (2) To determine the influence of STEM activities towards lower secondary students' enrolment into upper secondary.
- (3) To elucidate secondary school teachers' opinions on the influence of STEM activities towards Math and Science.
- (4) To develop a framework for enhancing STEM programs in secondary schools.

The research framework (Figure 1.1) illustrates the variables under investigation. From left, three groups of entities formed the main respondents or participants of the research. Aligning with the first objective, this study investigates the impact of STEM activities on upper primary school students' motivational beliefs about science subjects. The data will be gathered via quantitative and qualitative methods. To meet the second objective, data were collected from the second entity of respondents and participants to determine the influence of STEM activities on lower secondary students' enrolment into upper secondary. Similar to the previous objective, quantitative and qualitative methods were employed. Then, the third entity of schoolteachers would provide their insights into the influence of STEM activities on students' interest in Math and science subjects. This is aligned with the third objective; data collected through a qualitative method. Finally, once the three objectives have been achieved, the findings are used to establish a framework for enhancing the implementation of STEM activities or programs at schools, in meeting the fourth objective. In other words, the framework

is built upon the data derived from the three entities at schools, namely, the primary and secondary school students, and their teachers.

1.8 RESEARCH FRAMEWORK

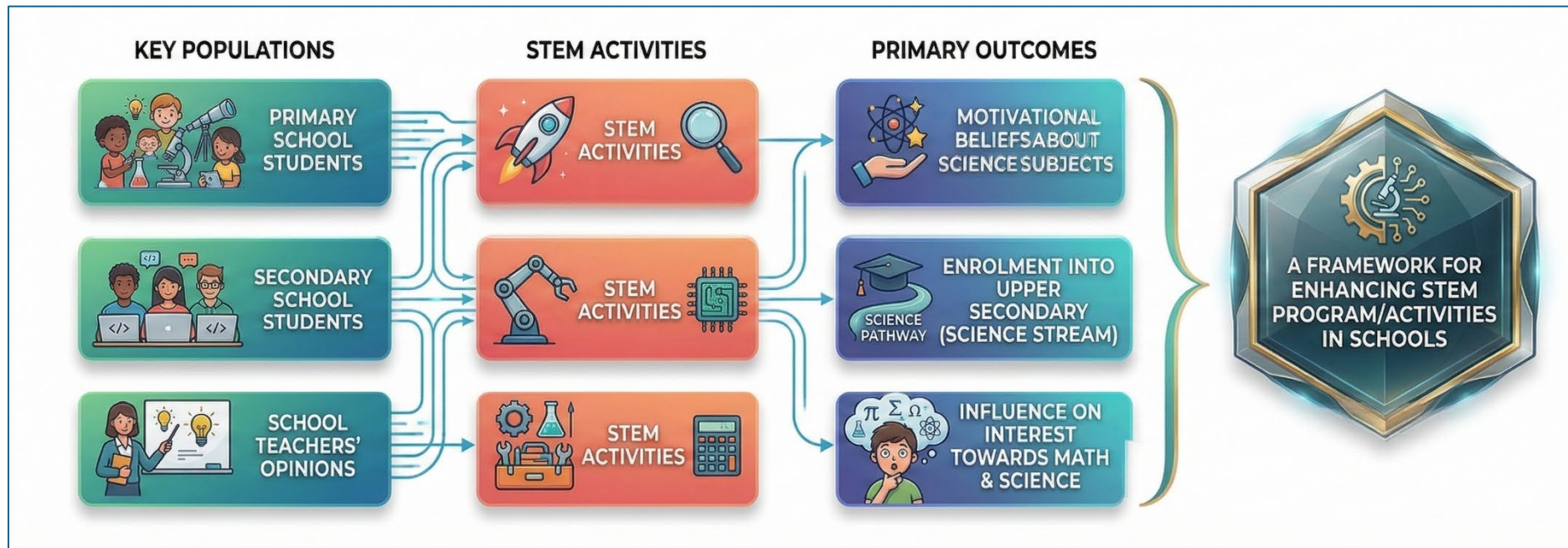


Figure 1.1: Research framework based on the four objectives guiding this research

1.9 RESEARCH SIGNIFICANCE

This research is significant as it provides systematic and empirical insight into how STEM activities influence school students' motivation to pursue studies in STEM-related fields within the specific context of DUN N8 Satok, Sarawak. While national and international studies highlight declining student interest in STEM disciplines, there remains limited localized evidence explaining whether existing STEM initiatives in Satok effectively shape students' motivational beliefs, academic engagement, and future educational choices. By addressing this gap, the study offers context-relevant findings that can guide stakeholders in strengthening STEM participation among school learners.

This research is also significant as it addresses the critical need to understand how STEM activities influence the motivation of school students in DUN N8 Satok to pursue studies in STEM-related fields, which is essential for developing a skilled workforce capable of meeting the demands of the Fourth Industrial Revolution. By investigating the specific factors that drive student interest and participation in STEM within this region, the findings will provide valuable insights for educators and policymakers to design targeted interventions that enhance STEM engagement and address the challenges of implementation at the school level (Benek & Dönmez, 2024; Idris et al., 2023). The theoretical contribution of this research lies in offering a holistic framework that combines cutting-edge instructional strategies, curriculum upgrades, and effective mentorship programmes to develop a lifelong interest in STEM subjects (Idris et al., 2023).

The study is also important for informing effective instructional design. Evidence shows that STEM-integrated or activity-based learning can significantly enhance students' critical thinking, creativity, collaboration, and engagement, thereby strengthening sustained motivation toward science and mathematics learning. Similarly, hands-on programmes and experiential STEM exposures such as science camps or interactive workshops—have been shown to stimulate students' interest and influence future decisions to pursue STEM pathways (Yildiz & Ecevit, 2024). Understanding these effects in Sarawak schools can guide teachers, curriculum developers, and policymakers in designing context-appropriate STEM activities that foster long-term academic motivation.

The study is also important for educational planning and policy development. Through a mixed-method approach involving students and teachers, the research will generate evidence-based recommendations and develop a practical framework to enhance the design, delivery, and sustainability of STEM programs in schools. Such outcomes can support schools, education authorities, and community stakeholders in improving teaching strategies, increasing student interest in mathematics and science, and encouraging continued enrolment in STEM pathways at upper secondary and tertiary levels.

Beyond the local context, the research contributes to broader national and state aspirations for human capital development and innovation-driven economic growth. Strengthening motivation toward STEM education is essential for producing a skilled workforce capable of supporting technological advancement, research development, and emerging industries aligned with Industrial Revolution 4.0. The dissemination of findings through academic publications and conferences will further enrich the body of knowledge on STEM education and provide a valuable reference for future studies in Sarawak, Malaysia, and comparable educational settings. Furthermore, the research holds policy relevance for Malaysia's broader human-capital and workforce development goals. Strengthening students' motivation and self-efficacy in STEM from the primary and secondary levels is essential for nurturing future participation in science- and technology-driven fields (Razali et. al, 2020). Insights from Sarawak can therefore support equitable STEM development across regions, including rural and underserved communities, while informing targeted interventions to improve participation and achievement in mathematics and science.

Overall, this study provides theoretical, pedagogical, and policy contributions by clarifying the motivational impact of STEM activities on school students in Sarawak and offering evidence-based guidance for enhancing STEM education outcome

2.1 STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH)

STEM (Science, Technology, Engineering, and Math) is the heartbeat of the modern world. It's not just about lab coats and calculators; it's about equipping the next generation with the problem-solving DNA to tackle global challenges like climate change, digital privacy, and space exploration. In a world driven by rapid innovation, STEM activities transform passive consumers into active creators.

The global imperative for robust Science, Technology, Engineering, and Mathematics (STEM) education has transcended traditional pedagogical discourse to become a central pillar of national security, economic resilience, and societal innovation. As nations navigate the complexities of the fourth industrial revolution, the frequency of student participation in STEM activities, both within formal school structures and through informal out-of-school channels, serves as a vital barometer for future workforce readiness. This report provides an exhaustive examination of these participation frequencies on a global and localised scale, with a particular focus on the Malaysian and Sarawakian contexts. Furthermore, it delves into multidimensional motivational frameworks that influence primary and secondary students, synthesising longitudinal data and psychological theories to elucidate the mechanisms underlying student engagement and persistence.

STEM activities are closely aligned with Sustainable Development Goal 4 (Quality Education), which emphasises inclusive and equitable quality education and lifelong learning opportunities for all (United Nations, 2015). By engaging students in hands-on, inquiry-based, and technology-integrated learning, STEM initiatives foster critical thinking, creativity, and problem-solving skills essential for 21st-century citizenship and workforce readiness (Aspin et al., 2021; Lian et al., 2021). Moreover, such activities bridge the gap between theoretical knowledge and practical application, ensuring that students not only master content but also develop the competencies needed to address global challenges (Benek & Dönmez, 2024). In this way, STEM education directly contributes to SDG 4 by promoting accessible, relevant,

and future-oriented learning pathways that empower students to pursue science stream education and beyond.

2.2 GLOBAL STEM PARTICIPATION

Formal STEM participation is systematically monitored through large-scale international assessments that provide a granular view of how students interact with science and mathematics curricula across diverse education systems. The Trends in International Mathematics and Science Study (TIMSS), administered by the International Association for the Evaluation of Educational Achievement (IEA), remains a primary source of these frequencies. In the TIMSS 2023 cycle, the global reach of formal STEM assessment expanded significantly, involving 72 education systems. At the fourth-grade level, this involved approximately 359,098 students from 12,016 schools, while the eighth-grade assessments also saw extensive participation across 44 countries and various benchmarking entities (von Davier et al., 2024). This infrastructure not only measures achievement but also quantifies the sheer volume of student engagement with STEM concepts as a standard part of their mandatory education.

The shift toward digital assessment, which reached full transition in 2023, reflects a broader global trend in how STEM participation is facilitated (von Davier et al., 2024). This transition mirrors the increasing ubiquity of technology in modern society and ensures that STEM proficiency is measured in line with the digital competencies required in the contemporary world. However, the data also reveals significant disparities in participation frequency. Global out-of-school rates provide a sobering counter-perspective to enrolment figures. As of 2023, approximately 272 million children and youth are excluded from formal education systems (UNESCO, 2026). Of these, the upper secondary level is the most severely affected, with 130 million students, representing 48% of the total out-of-school population, missing critical opportunities to pursue advanced STEM pathways. The frequency of participation is inextricably linked to national wealth; in the poorest countries, the out-of-school rate stands at 36%, compared to only 3% in the richest nations (UNESCO, 2026).

2.3 THE EVOLUTION OF OUT-OF-SCHOOL (OST) STEM FREQUENCIES

While formal schooling provides the necessary theoretical foundation, Out-of-School Time (OST) STEM activities have emerged as a cornerstone of the global STEM ecosystem. These programs, which include afterschool clubs, summer camps, and competitive fairs, offer a less rigid environment that is conducive to identity formation and the development of 21st-century skills such as resilience and critical thinking (Sullivan, 2026). In the United States, research by the Afterschool Alliance demonstrates a clear upward trend in the frequency of STEM offerings in these informal settings. As of 2020, 73% of afterschool programs offered STEM learning opportunities, a 4-percentage-point increase since 2014 (Afterschool Alliance, 2021).

The frequency of participation within these programs is notably high. Approximately 60% of students attending afterschool programs engage in STEM activities at least twice a week, an 8-percentage-point increase from 2014 levels (Sullivan, 2026). Furthermore, 82% of participants engage in at least one STEM activity per week. This high frequency of engagement is particularly evident among high school students, where 66% report participating at least twice weekly. The variety of activities has also diversified significantly. Math remains the most frequently offered subject (62%), but technology and engineering programs have seen the most rapid growth, rising from 30% in 2014 to 39% in 2020 (Afterschool Alliance, 2021).

2.4 STEM PARTICIPATION IN MALAYSIA

Malaysia has implemented a strategic framework to drive STEM participation through its "60:40 Policy," which aims to achieve a 60:40 ratio of students enrolled in STEM fields to those in non-STEM streams. This policy, initially introduced in 1970 as a "Science/Technical" vs. "Literature" split, was rebranded in the Malaysia Education Development Plan 2013-2025 to reflect a more integrated STEM approach (Ramli & Awang, 2020).

Despite this longstanding policy, achieving the 60% target has been a challenge marked by significant fluctuations. In 2020, national STEM enrolment among upper secondary students reached 47.18%, but it declined sharply during the COVID-19 pandemic, to 40.95% in 2021 and 40.94% in 2022. This decline prompted urgent interventions from the Ministry of Education. By 2023, enrolment began to recover, reaching 45.73%. Most significantly, STEM

enrolment jumped to 50.83% as of June 2024. This surge, representing a nearly 10-percentage point increase over five years, is attributed to innovative learning approaches and a renewed focus on the practical applications of STEM (Gimino et al., 2024).

The recovery in participation is supported by large-scale national events. The Malaysian "Techlympics 2022" involved over one million participants aged 7 to 30 in various tech-based competitions, indicating a strong appetite for STEM engagement when framed through competitive and interactive mediums. Furthermore, the government aims to double the number of engineers by 2030, bringing the engineer-to-population ratio to 1:170, which is significantly lower than the 1:100 ratio seen in developed nations like Germany (Hazlin Hassan, 2024).

2.5 REGIONAL PARTICIPATION: THE SARAWAK STEM LANDSCAPE

The state of Sarawak provides a critical localised context within the broader Malaysian STEM framework. As of 2025, the enrolment rate for students in STEM streams in Form 4 and Form 5 across Sarawak reached 50.8%, aligning closely with the national average but still falling short of the state's post-COVID-19 Development Strategy (PCDS) 2030 target of 60% (The Borneo Post, 2025b). The frequency of STEM participation in Sarawak is shaped by its unique geography and the challenges of serving rural and interior communities.

2.6 RURAL INITIATIVES AND DIGITAL EXPOSURE

To increase STEM participation frequency among rural students, the Ministry of Education, Innovation and Talent Development (MEITD) Sarawak has launched several targeted programs. The "STEM Catalysts" initiative, for instance, visited 18 district education offices and engaged over 6,000 pupils from more than 130 primary schools in 2024 (The Borneo Post, 2025a). This program introduces students to advanced technologies like AI-controlled robotic arms, drone racing, and hydrogen generation. Additionally, over 1,200 primary schools statewide have been equipped with Raspberry Pi devices since 2021 to provide early exposure to programming and the Internet of Things (IoT) (The Borneo Post, 2025b).

However, actual digital usage within these schools remains variable. A preliminary study of Year 4 to 6 students in rural Sarawak found that, while students have "relatively good access" to smartphones, their use of technology for STEM learning is often "minimal" and passive, focusing on watching videos rather than engaging with interactive simulations or specialised apps. This gap between hardware availability and active participation suggests a need for more structured digital activities and teacher training (Naning et al., 2025).

2.7 SARAWAK EDUCATION ENHANCEMENT PROGRAMME (SEEP)

To address underperformance in the Sijil Pelajaran Malaysia (SPM) examinations, where Sarawak has historically ranked second from the bottom nationwide, the state government introduced the Sarawak Education Enhancement Programme (SEEP), allocating RM20 million for 2025. SEEP focuses on increasing the number of students eligible for STEM pathways by providing additional support in pure science subjects (Physics, Chemistry, Biology, and Additional Mathematics) for Form 4 and 5 students from low-income (B40) households (The Borneo Post, 2025b).

2.8 WHAT DRIVES STEM PARTICIPATION?

Understanding why students choose to participate in STEM is essential for designing effective curricula and interventions. Motivational research in STEM is often anchored in several prominent psychological theories: Expectancy-Value Theory (EVT), Self-Determination Theory (SDT), and Social Cognitive Theory (SCT). These frameworks explain how individual beliefs, social environments, and perceived task values interact to drive behaviour.

2.9 EXPECTANCY-VALUE FRAMEWORK

Expectancy-Value Theory (EVT) posits that a student's choice to engage in a STEM activity is determined by their expectation of success and the subjective value they place on the task. Value is further broken down into intrinsic value (enjoyment), utility value (usefulness for future goals), and attainment value (personal importance of success) (Wang & Degol, 2013).

Studies indicate that while a vast majority of secondary students recognise the "utility value" of STEM, 90% agree that STEM knowledge helps secure well-paying jobs, but only 40% expressed a definitive interest in pursuing a STEM-related major (Schnieders & Bobek, 2025). This discrepancy suggests that extrinsic motivation (future salary) is often overshadowed by internal factors such as interest and perceived "cost" (effort and difficulty). Students who find STEM subjects "complicated, boring, and unrelated to real-world practices" are less likely to persist, regardless of the perceived utility (The Borneo Post, 2025a).

2.10 SELF-EFFICACY

Self-efficacy, or the belief in one's ability to perform a task successfully, is a primary driver of STEM persistence. In a study of Malaysian students, a "very strong positive" relationship ($p = 0.896$) was found between self-efficacy and persistence in STEM streams. Students with high self-efficacy exhibit greater resilience when facing difficult subjects like Additional Mathematics and Physics. This belief system is often nurtured through successful early experiences, positive teacher reinforcement, and observational learning from role models (Nurul Yasmin et al., 2025).

2.11 INTRINSIC MOTIVATION AND AUTONOMY

Self-Determination Theory (SDT) suggests that students are more motivated when their needs for autonomy, competence, and relatedness are met. STEM activities that are student-led, inquiry-based, and collaborative tend to foster higher levels of intrinsic motivation. For example, participants in the "Studio STEM" afterschool program showed more resilient motivational beliefs compared to their peers because the program allowed them to grapple with concepts in a low-stakes, voluntary environment (Chittum et al., 2017). Intrinsic interest is the primary source of motivation for 30% of students participating in high-level out-of-school activities such as the Science Olympiad or Girls Who Code (Rommel & Yousef, 2024).

2.12 DEVELOPMENT AND DEMOGRAPHIC INFLUENCE ON MOTIVATION

The motivations for STEM participation evolve as students mature and are heavily influenced by demographic factors, including gender, socioeconomic status, and parental education.

2.13 PRIMARY VS. SECONDARY MOTIVATIONS

In the primary years, motivation is often driven by natural curiosity and the enjoyment of hands-on, materials-rich learning. However, interest frequently declines as students' progress into middle and secondary school, a phenomenon known as the "STEM slump" (Chittum et al., 2017). Secondary students are more likely to view STEM through the lens of performance and career prospects. A comparative study of high school and undergraduate students found that undergraduates are more motivated because they have actively chosen to study STEM, whereas high schoolers often view it as a mandatory requirement (Bayanova et al., 2023).

2.14 THE ROLE OF PARENTS

Parents play a pivotal role in shaping a child's STEM aspirations from an early age. Parental education level and occupational background are strong predictors of student interest. Students whose caregivers have a college degree are significantly more likely to express interest in STEM majors (44%) compared to those whose caregivers do not (32%) (Schnieders & Bobek, 2025). Furthermore, 86% of students from college-educated households know what STEM stands for, compared to 65% from other households (Schnieders & Bobek, 2025).

Parental involvement refers to the various ways parents engage in their children's education, including providing emotional support, learning resources, monitoring academic progress, and participating in school activities (Siani et al., 2020). In STEM education, such involvement has a profound effect. This supports Lloyd et al. (2018), who found that parental encouragement has a stronger influence than educational level alone. In Cambodia, more than half of parents encourage children toward non-science tracks due to limited awareness of science career opportunities (Pov et al., 2024). Conversely, in South Africa, many STEM students reported

family influence as “very influential” or “moderately influential” in their decision-making (Abe & Chikoko, 2020).

In Malaysia, parents’ awareness of the economic and professional value of STEM careers is crucial for motivating their children. Razali (2021) noted that students’ interest in STEM often develops in parallel with parental recognition of STEM’s global market relevance. Furthermore, Leng et al. (2020) found that students were significantly more likely to pursue STEM pathways if their parents held STEM-related occupations or provided active encouragement, even without direct career alignment. In Sarawak, the majority of students from low-income (B40) families have parents who attained only secondary school education, which is correlated with lower positive attitudes toward STEM learning (Ling & Mohd Syahiran, 2023).

This evidence highlights that parental support, whether through guidance, exposure, or encouragement, can shape students’ aspirations and increase their likelihood of pursuing the science stream. Therefore, based on past studies, it can be inferred that parental encouragement can influence students’ intention to pursue STEM education.

2.15 FACTORS INFLUENCING PERSISTENCE AND CHOICE

The decision to persist in a STEM pathway is a complex interaction of academic performance, institutional support, and individual characteristics.

- **Academic Achievement:** Grades are a significant "gatekeeper." High achievement in Form 3 science and math often dictates whether a student is eligible or confident enough to enter the STEM stream in upper secondary school (Nurul Yasmin et al., 2025).
- **Teacher and School Support:** Teaching methods are a critical school-level factor. Engagement levels are higher when teachers use evidence-based instructional practices, such as the 5E-STEM model (Engage, Explore, Explain, Elaborate, Evaluate) (Mohd Farid & Othman, 2025). Teacher enthusiasm and pedagogical content knowledge are also vital; students who rate their teachers as supportive and their classes as engaging report higher levels of interest (Ha et al., 2023).
- **Computational Thinking (CT) Integration:** In Sarawak, integrating CT across subjects has been shown to enhance problem-solving and critical-thinking skills. Over

50% of teachers reported improved student performance in STEM subjects following CT integration (Shariman et al., 2024).

- **Infrastructure and Resources:** The availability of STEM resources, such as laboratories and specialised software, is a critical environmental factor. The "packed curriculum" and "insufficient and aged infrastructure" are cited as major barriers to STEM interest in Malaysian secondary schools (The Borneo Post, 2025a).

2.16 IMPACT OF THE PANDEMIC AND DIGITAL SHIFT

The COVID-19 pandemic significantly disrupted STEM participation frequencies and shifted the motivational landscape. While school closures led to a decline in formal enrolment in Malaysia (from 47.18% in 2020 to 40.95% in 2021), it also accelerated the adoption of digital tools (Gimino et al., 2024). In the U.S., 76% of afterschool programs continued to provide STEM learning opportunities during the pandemic, showing the adaptability of the informal sector (Afterschool Alliance, 2021). However, the pandemic also highlighted the "digital divide," as students without reliable internet or home devices were disproportionately excluded from STEM engagement (Afterschool Alliance, 2021).

In Sarawak, the pandemic's impact on tourism and the economy served as a catalyst for the PCDS 2030, which emphasises a high-tech, digital economy as the way forward (Chiam, 2025). This regional strategy has placed renewed focus on STEM education as the engine of sustainable growth, leading to initiatives such as SEEP and the Raspberry Pi rollout to ensure that the next generation is equipped for a post-pandemic world (The Borneo Post, 2025b).

2.17 GLOBAL AND LOCAL STEM TRENDS

The synthesis of available data suggests that STEM participation is currently in a state of flux, characterised by recovery and diversification. Globally, the frequency of informal STEM participation is rising, yet formal secondary education faces a "leak" in the pipeline, exacerbated by socioeconomic and regional disparities. Locally, Malaysia is seeing a significant rebound in STEM enrolment as of 2024, though it remains below its 60% policy target (The Borneo Post, 2025a).

Motivation remains the "engine" of participation. While extrinsic rewards like high salaries are recognised, they are insufficient to sustain engagement if a student lacks self-efficacy or finds the subject matter irrelevant to their life. Successful interventions, such as Sarawak's STEM Catalysts or global programs like the International Science and Engineering Fair (ISEF), succeed by bridging the gap between classroom theory and real-world application, fostering a sense of belonging and identity within the STEM community (The Borneo Post, 2025a).

The evidence underscores that participation is not just a matter of school enrolment but a multi-layered ecosystem of formal learning, out-of-school engagement, parental support, and psychological resilience. To achieve sustained participation, educational systems must move beyond "mandatory" STEM to "meaningful" STEM, where students feel empowered, capable, and motivated to innovate. The future of global and local STEM depends on making these opportunities frequent, equitable, and intrinsically rewarding for all students, regardless of their background or geography.

3.1 RESEARCH DESIGN

The research design used a mixed-methods approach which combined quantitative and qualitative methods to fully understand the effects of STEM experiences. The design structure allowed researchers to conduct two separate methods which included student and teacher questionnaire distribution for quantitative data collection and open-ended questions and focused group discussions for qualitative data collection. The research design enables sufficient guidance of the study because it examines student motivational beliefs together with their STEM stream entry attitudes and teacher perspectives and STEM program enhancement routes.

3.2 PARTICIPANTS AND SAMPLING

The study population consisted of students and teachers from DUN N.8 Satok schools. A purposive sampling method was selected, specifying the schools and participants who had participated in the STEM programs conducted at the institutions. The research involved 78 students who took part in the investigation. This included 39 primary school students from three primary schools, namely SK Combined, SK Rakyat Haji Bolhassan, and SK Merpati Jepang. Additionally, a total of 39 students of the lower secondary schools, Form 3, were selected from two secondary schools, SMK Batu Kawa and St. Joseph. Participants identified by school teachers are students who are part of the Satok constituency. 10 STEM teachers were randomly selected to examine educator perspectives as well.

3.3 RESEARCH INSTRUMENTS

The researchers developed three questionnaires through their analysis of previous studies which proved relevant to the research. These questionnaires supported dual language and were prepared in both Bahasa Melayu and English for better understanding purposes among the students and teachers. Students and teachers evaluated the questions by rating using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.4 QUESTIONNAIRES FOR SECONDARY SCHOOL STUDENTS

The survey investigated which STEM activities students used to select their future academic direction. The survey instrument asked participants to share their demographic information, frequency of participation, and technology usage which included robotics kits and 3D printers. The survey contained an essential part which measured how students learned science content and developed their interest in science through their practical activities. The research investigated student career decision processes through their individual preferences and their academic achievements. The instrument evaluated how Science and Mathematics learning directly affected students through their confidence growth and their interest development and their self-motivated exploration of academic subjects.

3.5 QUESTIONNAIRES FOR PRIMARY SCHOOL STUDENTS

The research tool for this study used a version of the instrument which targeted children between 10 and 12 years old to measure their motivational beliefs. The research examined which factor motivated students to join science and math activities between their personal interest in learning and the backing they received from their parents and teachers and friends. The survey assessed student engagement through two questions which asked students to rate how technology integration and facilitator support affected their learning experience. The students from the secondary group received instructions to evaluate how these activities impacted their Science and Mathematics subject confidence and their level of excitement.

3.6 QUESTIONNAIRES FOR TEACHERS

The teacher questionnaire functioned to obtain professional assessments regarding STEM program effectiveness. The research started by gathering information about how long educators taught and what STEM education training they completed. The teachers needed to determine if the activities actually helped their students develop critical thinking skills and creative thinking and problem-solving abilities. The survey included a major section which examined organizational and operational difficulties through questions about financial support and management assistance and available resources.

3.7 OPEN-ENDED QUESTIONS

Meanwhile, for the open-ended questions for both primary and secondary students, they were allowed to provide qualitative feedback on how STEM activities make learning Science and Mathematics fun, what's good for learning Science and Mathematics, ideas about future STEM activities, and how the use of technology in STEM activities can work in schools. The open-ended questions for the teachers require the teachers to give challenges and struggles when implementing STEM activities, additional comments or insights regarding the influence of STEM activities and teaching resources that are available to teachers to improve student motivation in STEM activities.

3.8 DATA COLLECTION

The data collection process consisted mainly of two stages, namely: Phase One was to prepare and distribute questionnaires to the selected students and their teachers in the selected schools. The research team needed to perform thorough focus group interviews with both students and their teachers who participated in the study. The data collection was a hands-on, facilitated process designed to support the students. A team consisting of one lead researcher and two Research Assistants visited the schools personally to administer the survey as shown in Figure 1. The team members took an active role to assist students with their questionnaire completion because they wanted to confirm students grasped all the questions. The research team used written surveys to gather data but conducted interviews to get detailed student responses through open-ended questioning. The research team conducted Phase Three to evaluate both numerical and non-numerical data which they collected during Phase 2.

3.9 DATA ANALYSIS

Once the data are collected, data analysis is done using SPSS version 26 software. The quantitative survey data was analysed using Descriptive statistics to summarise demographic information through frequencies and percentages. It is also to identify statistical patterns which showed student motivation levels and how STEM programs affected student interest in STEM subjects. Lastly, the open-ended questionnaire responses were analysed together with interview

data to discover thematic patterns which showed how participants experienced STEM activities and their opinions about STEM quality and required improvements.

4

RESULTS AND DISCUSSION

4.1 PRIMARY SCHOOL STUDENTS

4.1.1 Demographic Profiles

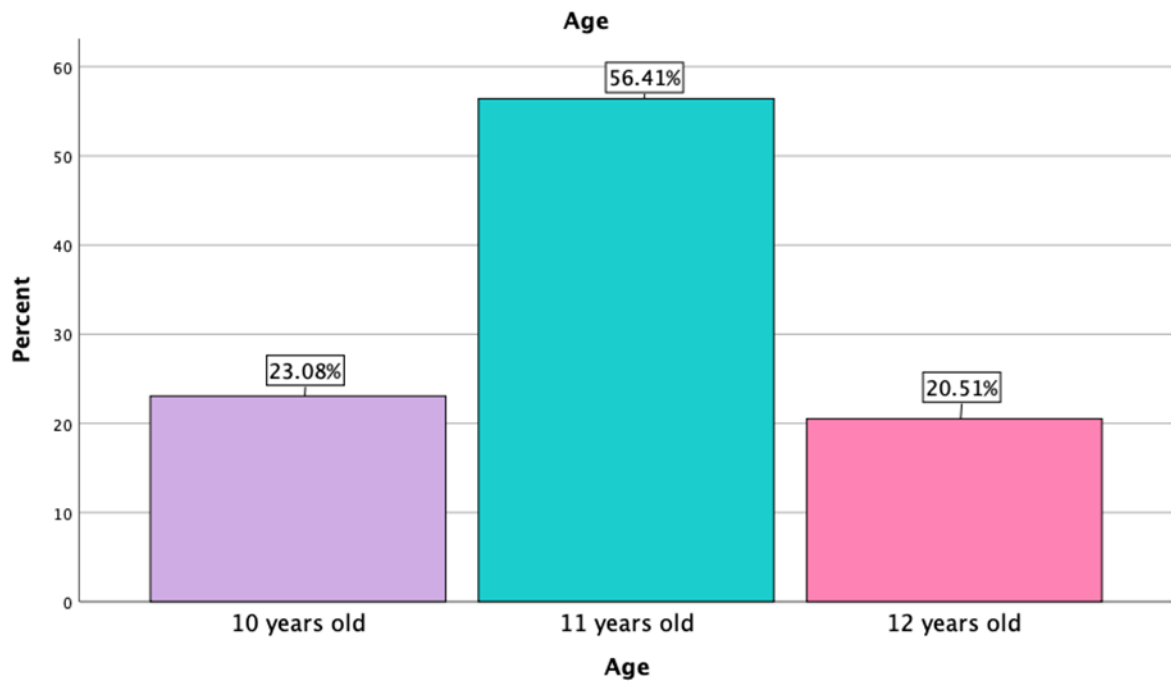


Figure 4.1: Age of respondents

Figure 4.1 illustrates the distribution of students' ages. The data indicates that the largest cohort of primary school students comprised 11 year olds, representing the majority at 56.4% (N=22). The remaining participants were nearly equally distributed between 10 year olds (23.1%, N=9) and 12 year olds (20.5%, N=8).

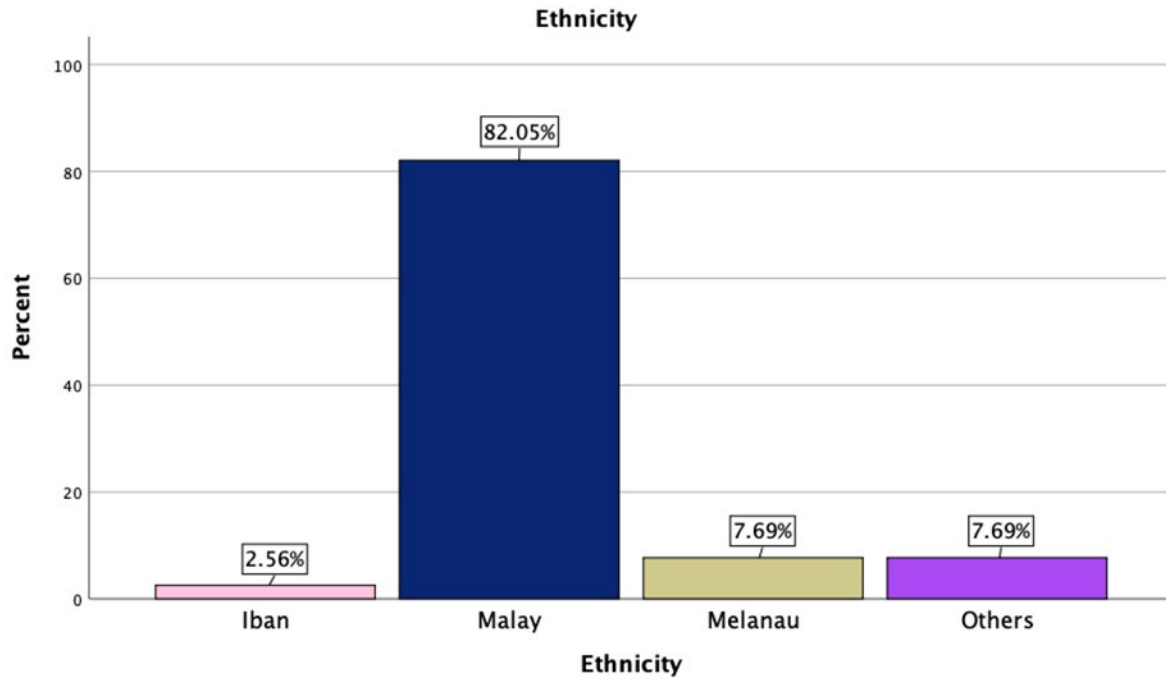


Figure 4.2: Ethnicity

Figure 4.2 presents the distribution of ethnic groups among the primary school students. The majority of students are Malay, comprising 82.1% (N=32). The remaining students are distributed across three smaller groups which are Melanau and the category “Others” each account for 7.7% (N=3 each), while the Iban group constitutes the smallest proportion at 2.6% (N=1).

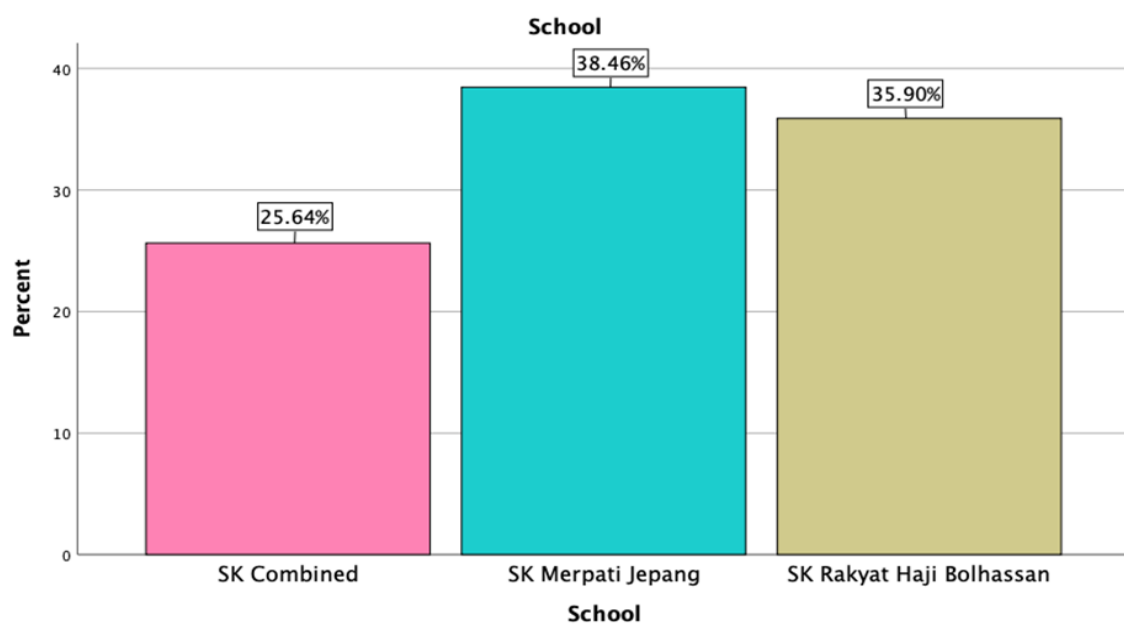


Figure 4.3: Schools

The distribution of participating schools in this study is shown in Figure 4.3. The highest representation originated from SK Merpati Jepang (38.5%, N=15), closely followed by SK Rakyat Haji Bolhassan (35.9%, N=14). The school with the minimum number of students was SK Combined (25.6%, N=10).

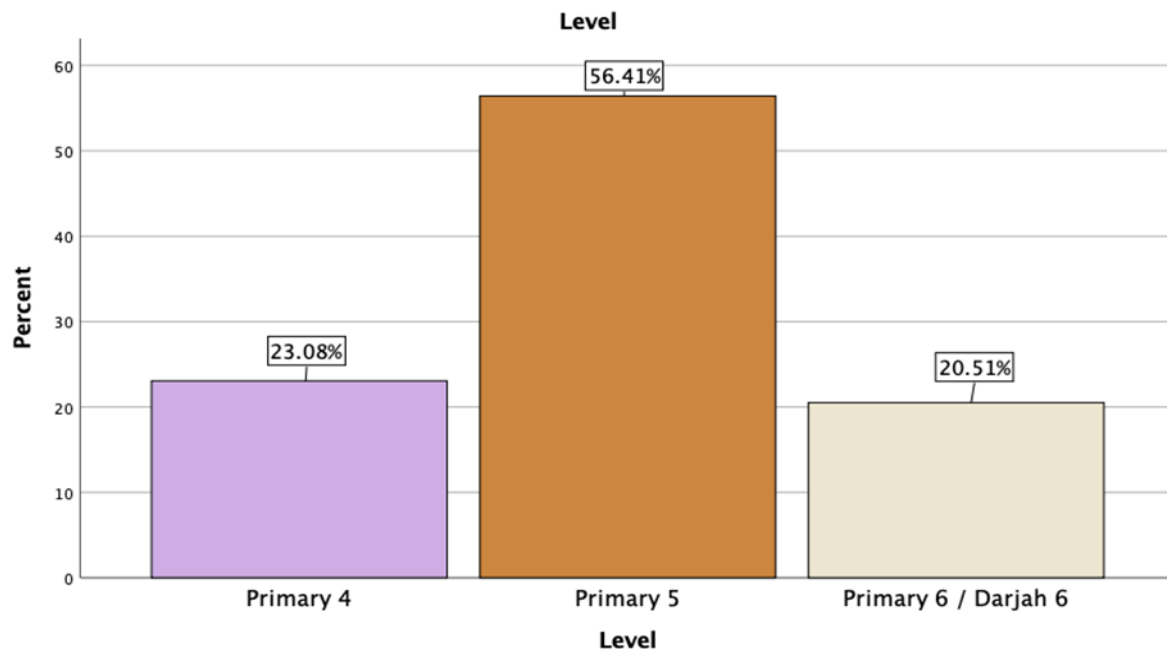


Figure 4.4: Level of schooling

Figure 4.4 displays the distribution of primary school students according to their academic level, which corresponds to their age. Primary 5 students constitute the largest group (56.4%, N=22), while the remaining students are almost equally divided between Primary 4 (23.1%, N=9) and Primary 6 (20.5%, N=8).

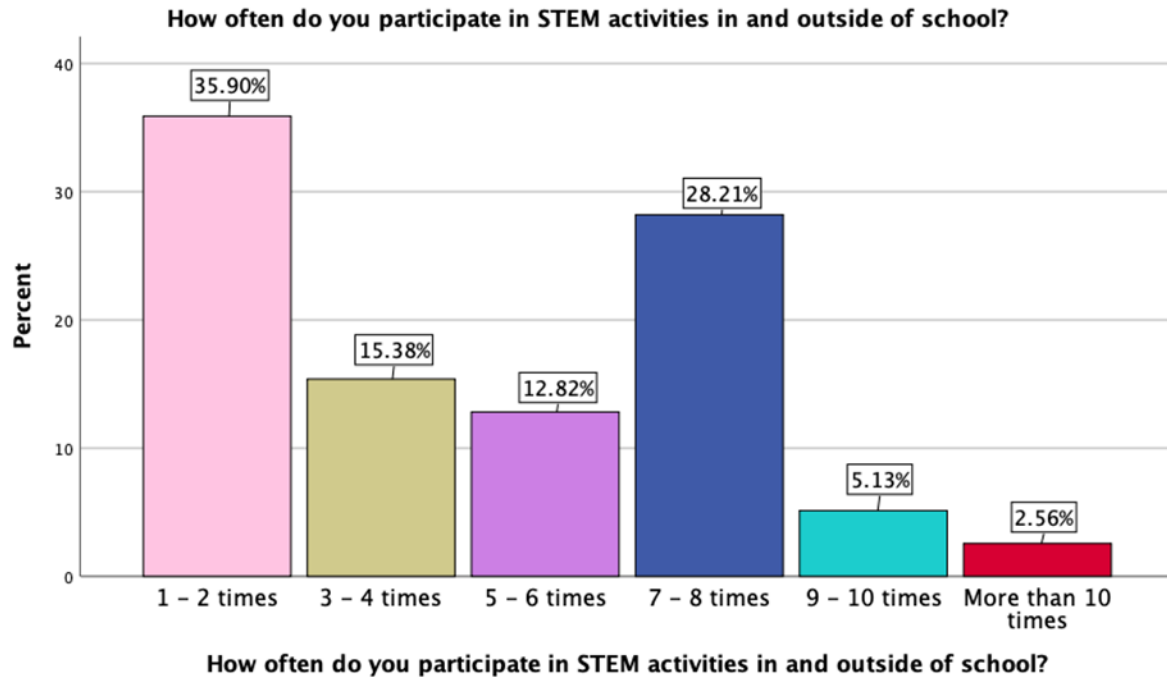


Figure 4.5: Frequency of participation in STEM activities

The frequency of engagement in STEM activities, both in and out of school by primary school students is displayed in Figure 4.5. The largest group reported the lowest frequency, with 35.9% (N=14) participating only 1–2 times while about 28.2% (N=11) of the students report a significantly higher engagement level of 7–8 times. Intermediate engagement levels were observed at 3–4 times (15.4%, N=6) and 5–6 times (12.8%, N=5). The highest engagement frequencies were rare, with 5.1% (N=2) participating 9–10 times and 2.6% (N=1) participating more than 10 times.

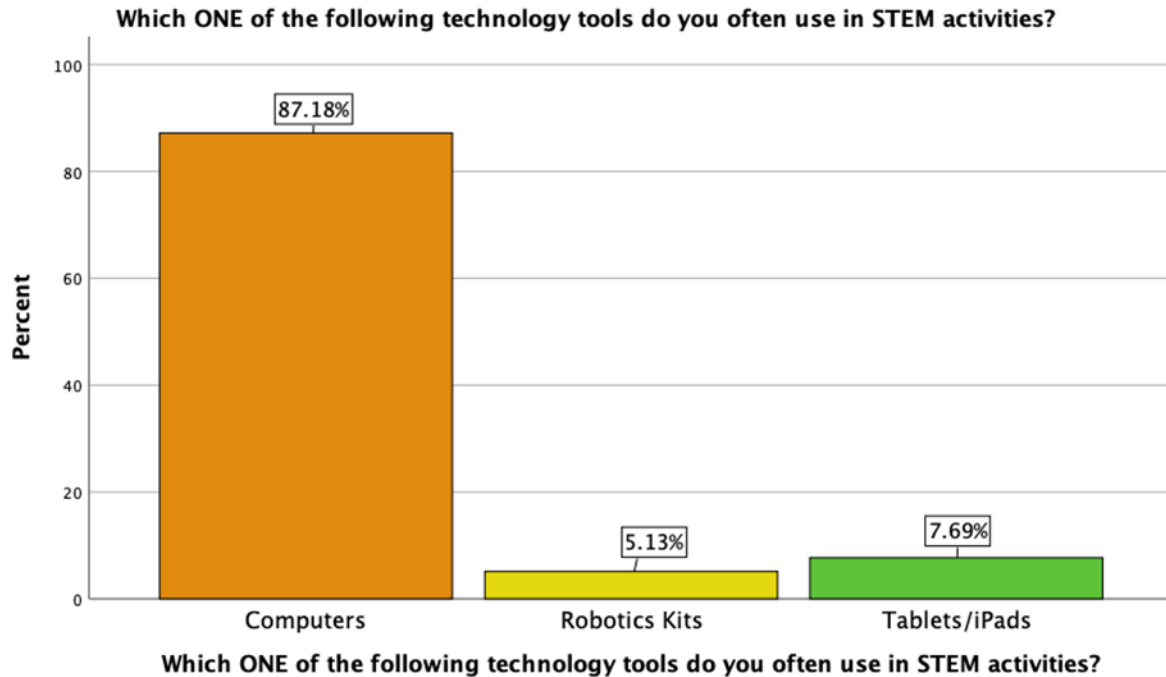


Figure 4.6: The most used technology tools in STEM activities

Figure 4.6 illustrates the technology tools most frequently utilized in STEM activities. The majority of students (87.18%, N=34) reported using computers for their STEM engagements. A smaller proportion of students utilized tablets/iPads (7.69%, N=3) and robotic kits (5.13%, N=2) to conduct STEM activities.

4.1.2 Reliability Test

Table 4.1: Reliability Test

Variable	Number of Items	Cronbach's Alpha (α)
Motivation to participate in STEM Activities	9	0.788
Impact STEM Activities on Students' Motivation in Learning Science	9	0.751
Impact STEM Activities on Students' Motivation in Learning Mathematics	9	0.894

The reliability analysis presented in Table 4.1 indicates a high degree of internal consistency across all three variables, namely motivation to participate in STEM Activities ($\alpha = 0.788$), the impact of STEM on students' motivation in learning Science ($\alpha = 0.751$), and the impact of

STEM on students' motivation in learning Mathematics ($\alpha = 0.894$). Nunnally (1978) recommended that all Cronbach's Alpha coefficients are acceptable if the threshold is at least 0.70.

4.1.3 Normality Test

Table 4.2: Normality Test

Variable	Skewness
Motivation to participate in STEM Activities	-1.201
Impact STEM Activities on Students' Motivation in Learning Science	-0.624
Impact STEM Activities on Students' Motivation in Learning Mathematics	-0.958

Table 4.2 shows the normality test based on skewness values, which indicates an approximately normal distribution for all variables, as the values within the generally accepted range of -2 to +2 (Hair et al., 2010). Specifically, the skewness for students' motivation to participate in STEM Activities is -1.201, for STEM's impact on students' motivation in learning Science is -0.624, and for STEM's impact on motivation in learning Mathematics is -0.958. Table 4.3 provides the interpretation scale for mean scores, as adapted from Moidunny (2009). The mean score for each variable is computed by dividing the total scores by the number of respondents and subsequently categorized according to the criteria outlined in Table 4.3.

4.1.4 Mean Score of Agreement

Table 4.3: Level of Motivation and Impact of STEM Activities in Learning Science and Mathematics (Adapted from Moidunny (2009))

Mean Score	Interpretation
1.00 – 1.80	Strongly disagree
1.81 – 2.60	Disagree
2.61 – 3.20	Moderately agree
3.21 – 4.20	Agree
4.21 – 5.00	Strongly agree

Table 4.4 indicates that all variables fall within the “Agree” range (3.21 – 4.20). Students’ motivation to participate in STEM activities registered the highest mean score at 4.1282, followed by the impact of STEM on Science learning motivation (3.9972) and Mathematics learning motivation (3.8519).

Table 4.4: Mean Score According to Motivation to Participate in STEM Activities, Impact of STEM on Students’ Motivation in Learning Science and Mathematics

Variable	Mean Score Level	
Motivation to participate in STEM Activities	4.1282	Agree
Impact STEM Activities on Students’ Motivation in Learning Science	3.9972	Agree
Impact STEM Activities on Students’ Motivation in Learning Mathematics	3.8519	Agree

4.1.5 Motivation to Participate in STEM Activities

Table 4.5 shows the strongest areas of agreement for students’ motivation reached “Strongly Agree” levels: “I feel excited to join the STEM activities” ($M = 4.62$, $SD = 0.544$), “My parents encouraged me to participate in STEM activities” ($M = 4.38$, $SD = 0.847$), and “The facilitators were helpful during STEM activities” ($M = 4.33$, $SD = 0.898$). The lowest agreement fell in the “Agree” range for “I participate in STEM activities because I am interested in Mathematics subjects” ($M = 3.56$, $SD = 1.095$).

Table 4.5: Motivation to Participate in STEM Activities

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
I participate in STEM activities because I am interested in Science subjects.	0 (0.0%)	1 (2.6%)	14 (35.9%)	20 (51.3%)	4 (10.3%)	3.69	0.694
I participate in STEM activities because I am interested in Mathematics subjects.	1 (2.6%)	7 (17.9%)	8 (20.5%)	15 (38.5%)	8 (20.5%)	3.56	1.095
I feel excited to join the STEM activities.	0 (0.0%)	0 (0.0%)	1 (2.6%)	13 (33.3%)	25 (64.1%)	4.62	0.544
My parents encouraged me to participate in STEM activities.	0 (0.0%)	2 (5.1%)	3 (7.7%)	12 (30.8%)	22 (56.4%)	4.38	0.847
My teachers encourage me to participate in STEM activities.	1 (2.6%)	2 (5.1%)	5 (12.8%)	17 (43.6%)	14 (35.9%)	4.05	0.972
My friends encourage me to participate in STEM activities.	3 (7.7%)	2 (5.1%)	5 (12.8%)	13 (33.3%)	16 (41.0%)	3.95	1.213

I think using technology in STEM activities makes learning more interesting.	3 (7.7%)	1 (2.6%)	3 (7.7%)	6 (15.4%)	26 (66.7%)	4.31	1.217
I feel that technology helps me understand STEM concepts better.	1 (2.6%)	1 (2.6%)	4 (10.3%)	14 (35.9%)	19 (48.7%)	4.26	0.938
The facilitators were helpful during STEM activities.	1 (2.6%)	1 (2.6%)	2 (5.1%)	15 (38.5%)	20 (51.3%)	4.33	0.898

4.1.6 Motivation in Learning Science

Table 4.6: Motivation in Learning Science

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
I feel more confident in learning Science now.	2 (5.1%)	1 (2.6%)	12 (30.8%)	16 (41.0%)	8 (20.5%)	3.69	1.004
I find Science easier to understand now.	3 (7.7%)	3 (7.7%)	8 (20.5%)	16 (41.0%)	9 (23.1%)	3.64	1.158
I understand how Science is useful in daily life.	0 (0.0%)	0 (0.0%)	5 (12.8%)	21 (53.8%)	13 (33.3%)	4.21	0.656
I enjoy learning Science more than before.	0 (0.0%)	1 (2.6%)	4 (10.3%)	13 (33.3%)	21 (53.8%)	4.38	0.782
I am excited to answer more questions related to Science.	4 (10.3%)	1 (2.6%)	13 (33.3%)	13 (33.3%)	8 (20.5%)	3.51	1.167
I would recommend STEM activities related to Science to my friends.	2 (5.1%)	3 (7.7%)	5 (12.8%)	11 (28.2%)	18 (46.2%)	4.03	1.181
I feel that STEM activities related to	2 (5.1%)	0 (0.0%)	4 (10.3%)	10 (25.6%)	23 (59.0%)	4.33	1.034

Science should be done more often in school. I would like to take part in more STEM activities related to Science. I am more likely to explore Science topics on my own because of STEM activities.	0 (0.0%)	1 (2.6%)	9 (23.1%)	14 (35.9%)	15 (38.5%)	4.10	0.852
	0 (0.0%)	1 (2.6%)	9 (23.1%)	15 (38.5%)	14 (35.9%)	4.08	0.839

The descriptive statistics analysis presented in Table 4.6 reveals that the highest level of agreement (“Strongly Agree”) was recorded for the items “I enjoy learning Science more than before” ($M = 4.38$, $SD = 0.782$) and “I feel that STEM activities related to Science should be done more often in school” ($M = 4.33$, $SD = 1.034$). Conversely, the item exhibiting the lowest mean score, indicating the least excitement, is “I am excited to answer more questions related to Science” ($M = 3.51$, $SD = 1.167$).

4.1.7 Motivation in Learning Mathematics

Table 4.7: Motivation in Learning Mathematics

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
I feel more confident in learning Mathematics now.	3 (7.7%)	4 (10.3%)	5 (12.8%)	12 (30.8%)	15 (38.5%)	3.82	1.275
I find Mathematics easier to understand now.	1 (2.6%)	4 (10.3%)	7 (17.9%)	14 (35.9%)	13 (33.3%)	3.87	1.080
I understand how Mathematics is useful in daily life.	1 (2.6%)	2 (5.1%)	12 (30.8%)	12 (30.8%)	12 (30.8%)	3.82	1.023
I enjoy learning Mathematics more than before.	0 (0.0%)	4 (10.3%)	5 (12.8%)	13 (33.3%)	17 (43.6%)	4.10	0.995
I am excited to answer more questions related to Mathematics.	2 (5.1%)	6 (15.4%)	5 (12.8%)	18 (46.2%)	8 (20.5%)	3.62	1.138
I would recommend STEM activities related to Mathematics to my friends.	4 (10.3%)	2 (5.1%)	8 (20.5%)	11 (28.2%)	14 (35.9%)	3.74	1.292

I feel that STEM activities related to Mathematics should be done more often in school.	4 (10.3%)	1 (2.6%)	3 (7.7%)	6 (15.4%)	25 (64.1%)	4.21	1.321
I would like to take part in more STEM activities related to Mathematics.	2 (5.1%)	4 (10.3%)	2 (5.1%)	16 (41.0%)	15 (38.5%)	3.97	1.158
I am more likely to explore Mathematics topics on my own because of STEM activities.	5 (12.8%)	3 (7.7%)	6 (15.4%)	17 (43.6%)	8 (20.5%)	3.51	1.275

Table 4.7 indicates students' motivation in learning Mathematics. The highest mean score ((M = 4.21, SD = 1.321), categorised as "Strongly Agree," corresponds to the item, "I feel that STEM activities related to Mathematics should be done more often in school." Conversely, the lowest mean score (M = 3.51, SD = 1.275), which falls within the "Agree" range, is associated with the statement, "I am more likely to explore Mathematics topics on my own because of STEM activities."

4.1.8 Open – Ended Questions

QUESTION 1

How do STEM activities make Science and Mathematics more fun for you?

STEM activities make Science and Mathematics more fun by prioritizing hands-on, enjoyable experiences such as experiments, projects (like water rockets), and games, which students often describe using positive terms like “seronok” (fun), “menarik” (exciting), and “best” (awesome). These activities effectively enhance the simultaneous and pleasant understanding of both subjects, making them more appealing than traditional classroom methods. Additionally, the fun factor is boosted by key motivators like collaborative group work, social interaction, the opportunity for creativity, and the integration of technology, particularly computers.

QUESTION 2

What kind of STEM activities help you understand Science and Mathematics better?

Practical, interactive, and technology-integrated STEM activities are consistently highlighted by students as the most effective for enhancing comprehension of science and mathematics, offering a deeper understanding than traditional instruction. Specific examples include hands-on experiments, projects like water rockets, robots, simple machines, big bubble activities, and model building, which make abstract concepts (e.g., numbers, temperature, human organs, calculations) more tangible and engaging. Furthermore, quiz games, interactive computer games, calculation-based tasks, and teacher-guided “cool projects” (such as hydrogen activities, coding, and basic arithmetic operations) are also highlighted as those that help reinforce and clarify science and math concepts.

QUESTION 3

Do STEM activities make you more interested in Science and Mathematics? Why or why not?

A vast majority of students (around 90%) reported that STEM activities significantly boost their interest in Science and Mathematics. This is largely attributed to the enjoyable, practical, and hands-on nature of the projects (such as building rockets, coding, and experiments), which render abstract concepts more engaging and fun than standard classroom instruction. The primary factors driving this increased interest include the excitement generated by diverse,

mind-stimulating activities that facilitate deeper learning, improved comprehension through exposure to real-world applications, and the positive social element of working in groups. A smaller proportion of students noted pre-existing interest in Science over Math or cited parental encouragement.

QUESTION 4

How can the use of technology in STEM activities be improved at your school?

Students recommended enhancing technology access by providing more computers, laptops, tablets, and robotics kits, alongside faster/better internet connectivity to support interactive learning. They emphasize incorporating advanced tools like AI, interactive computer games, and multimedia (e.g., TV monitors). Furthermore, students proposed increasing the frequency of varied STEM activities that effectively utilize this technology, equipping every classroom with dedicated technology resources, and highlighting beneficial educational games to maintain engagement in the activities.

QUESTION 5

What kind of STEM activities do you wish to engage in the future?

Students expressed strong interest in hands-on, creative technology-focused activities, particularly robotics (minibots, drones), coding (Scratch games, programming robots), and engineering projects like designing versatile rockets, airplanes, and inventions from recycled materials. They also favor interactive gaming (number-shooting games, interactive quizzes), science quizzes, hydrogen experiments, and unique experiments, alongside creative tasks such as song creation, colouring STEM posters, and crime investigation simulations using cipher codes.

4.2 SECONDARY SCHOOL STUDENTS

4.2.1 Demographic Profiles

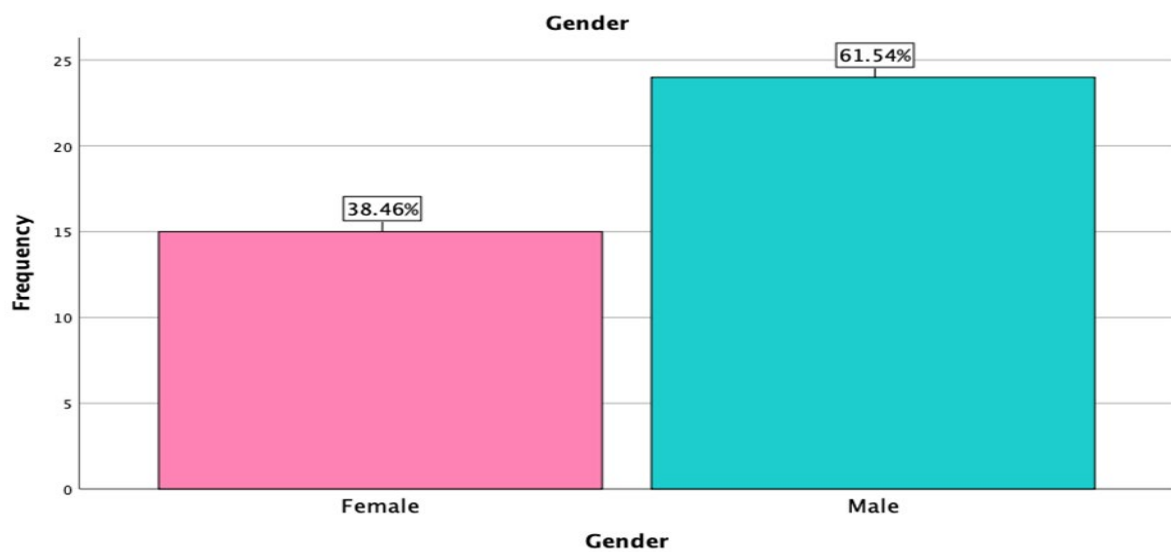


Figure 4.7: Gender of respondents

Out of the 39 secondary school students who participated in the study, a majority were male, accounting for 61.5% (N=24) of the total demographic data presented in Figure 4.7. Female students made up the remaining 38.5% (N=15) of the respondents.

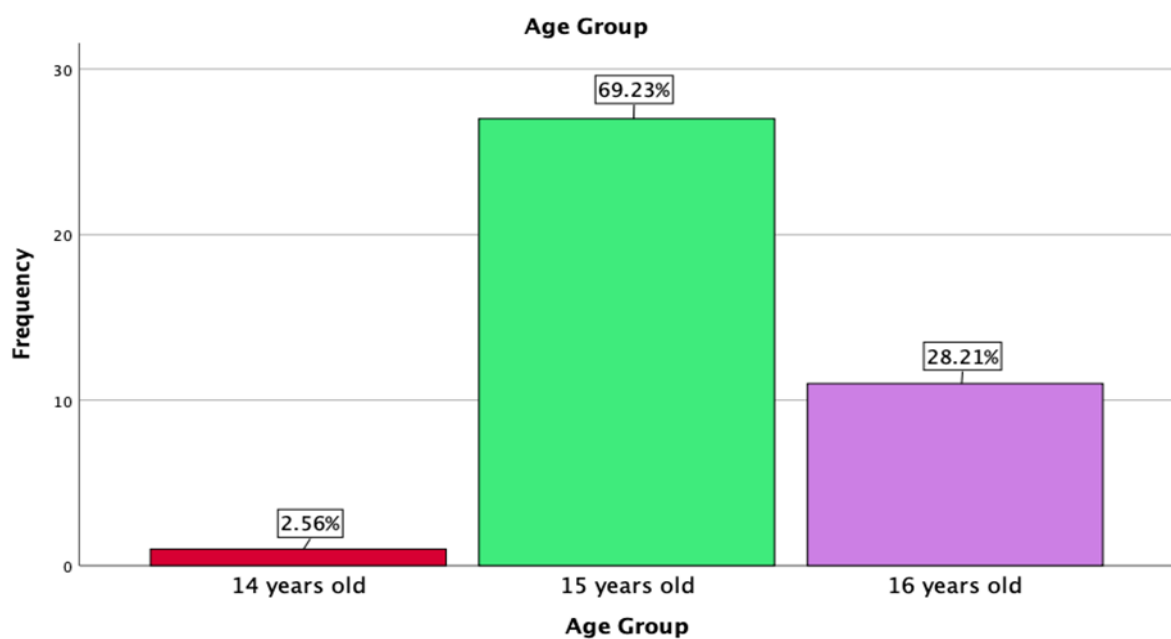


Figure 4.8: Age of respondents

Figure 4.8 illustrates the age distribution of the 39 secondary school respondents, showing that the vast majority of participants are 15 years old, comprising 69.2% (N=27) of the group. The next largest cohort consists of 16 year-olds, accounting for 28.2% (N=11) of the total, while the smallest group is 14 years old, representing 2.6% (N=1) of the secondary school student participants.

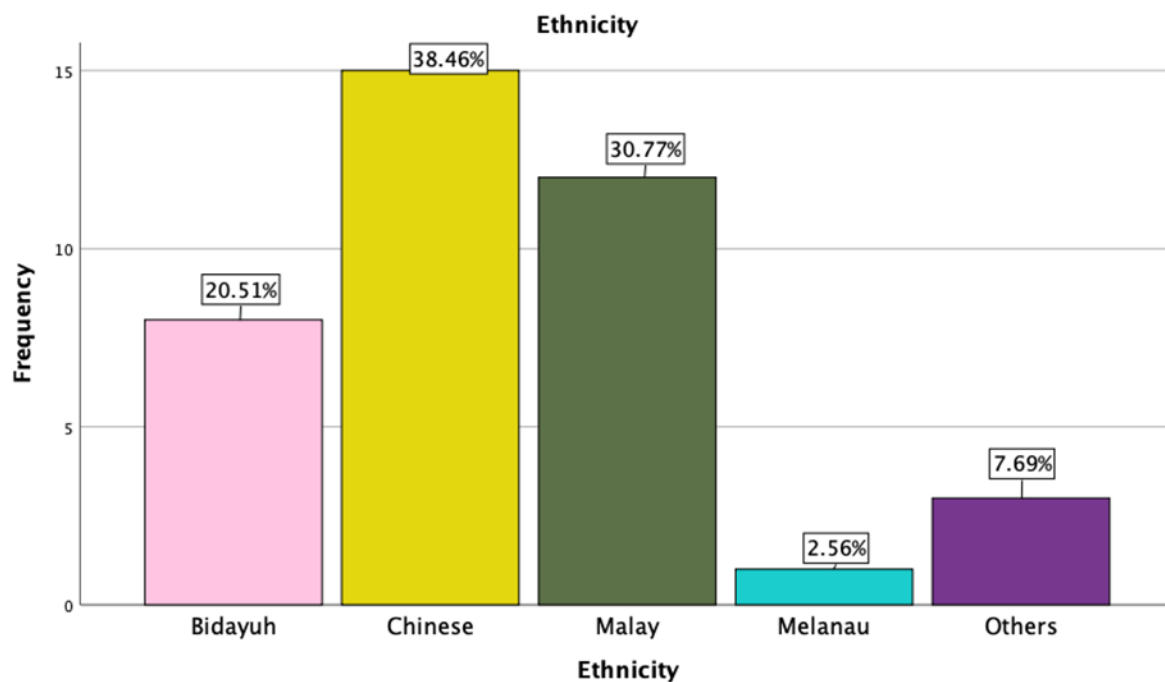


Figure 4.9: Ethnicity

Figure 4.9 displays the ethnic composition of the 39 secondary school respondents, revealing a diverse profile. The largest group of participants were Chinese students, comprising 38.5% (N=15) of the total. This was followed by Malay students, who constituted 30.8% (N=12). The third-largest ethnic group was Bidayuh, accounting for 20.5% (N=8) of the respondents. The remaining participants included students from the "Others" category at 7.7% (N=3) and Melanau students, who formed the smallest proportion at 2.6% (N=1).

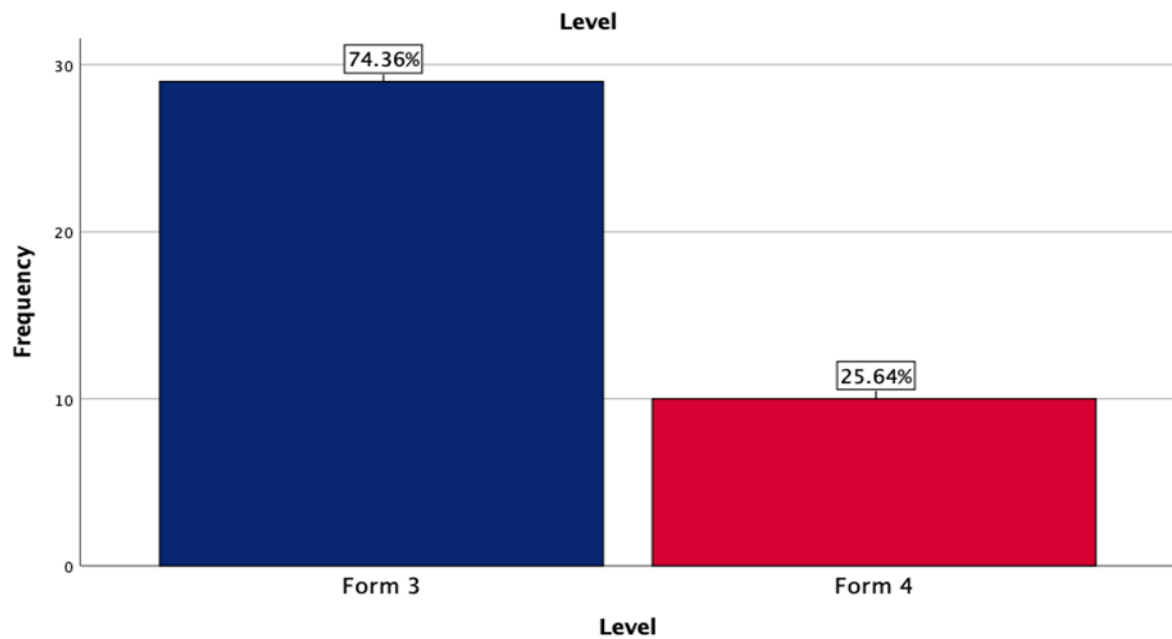


Figure 4.10: Level of study

The academic levels of the 39 secondary school students involved in the study are displayed in Figure 4.10. The analysis shows that the vast majority of the respondents were enrolled in Form 3, making up 69.2% (N=27) of the total participants. The next largest group was students in Form 4, accounting for 28.2% (N=11). The smallest group represented students in Form 2, with only one participant, constituting 2.6% (N=1) of the secondary school sample.

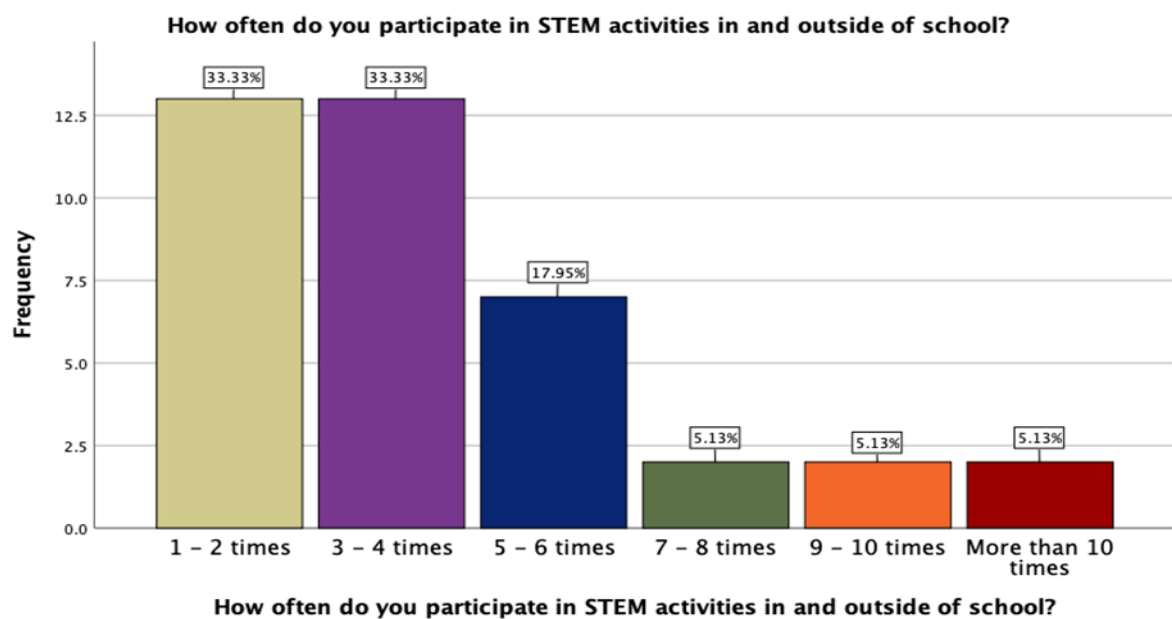


Figure 4.11: Frequency of participating in STEM Activities

The descriptive analysis from Figure 4.11 concerning the 39 secondary school respondents' frequency of participation in STEM activities indicates that engagement is predominantly at the lower end of the spectrum. Specifically, a combined two-thirds of the participants reported the lowest two frequency levels: '1–2 times' (33.3%, N=13) and '3–4 times' (33.3%, N=13). The next tier of engagement, '5–6 times', was reported by 17.9% (N=7) of the students. Conversely, the highest frequency categories—'7–8 times', '9–10 times', and 'More than 10 times'—were the least common, each accounting for a small 5.1% (N=2) proportion of the sample.

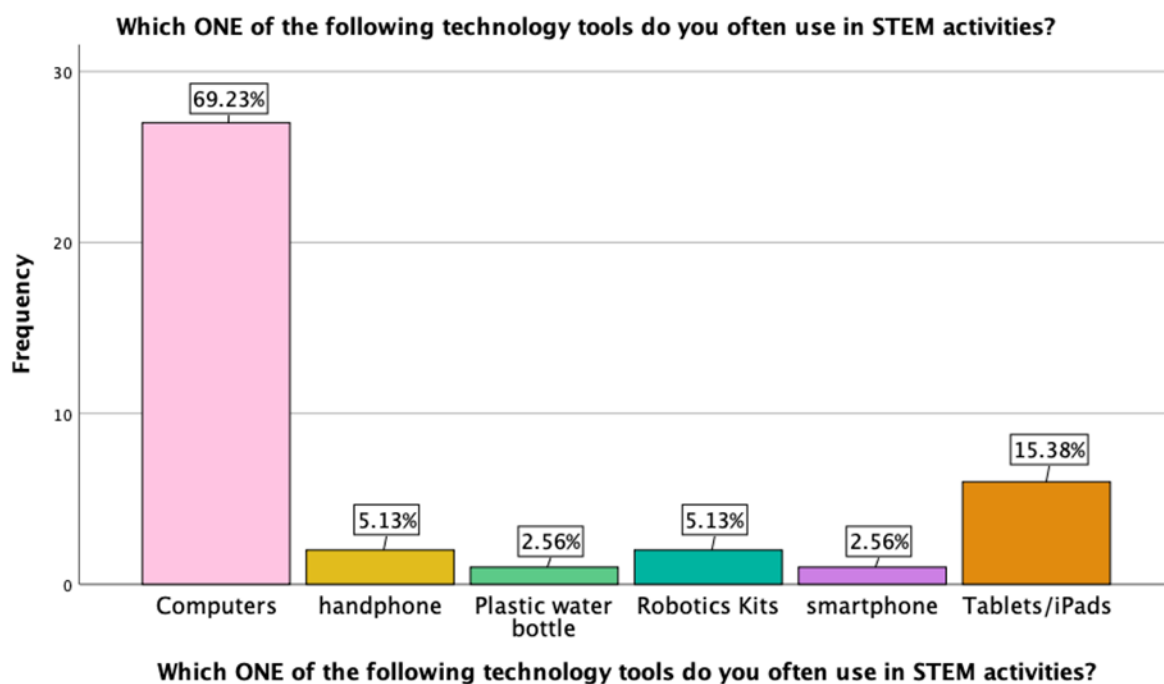


Figure 4.12: The Most Used Tools in STEM Activities

Figure 4.12, which illustrates the technology tools most frequently used by the secondary school respondents in STEM activities, shows a clear reliance on general computing devices. The Computer was the most utilized tool, reported by 69.2% of the students (N=27). This usage far surpassed that of other specialized or mobile devices. Following computers, the next most common tools were Tablet/iPads (15.4%, N=6), Handphones (7.7%, N=3), and Robotic kits (5.1%, N=2). The least frequently used tool was the Prototype Plastic water bottle, which was used by only 2.6% of the respondents (N=1).

4.2.2 Reliability Test

Table 4.8: Reliability Test

Variable	Number of Items	Cronbach's Alpha (α)
Influence of STEM Activities to Pursue Study	5	0.861
Influence of STEM Activities in Learning Science	9	0.934
Influence of STEM Activities in Learning Mathematics	9	0.911

The reliability analysis, as presented in Table 4.8, demonstrates a high degree of internal consistency across all three primary research constructs, with Cronbach's Alpha values ranging from 0.861 to 0.934. Consistent with the established criterion by Nunnally (1978), which posits that a Cronbach's Alpha value exceeding 0.7 indicates reliability, all items were deemed reliable. Specifically, the construct "Influence of STEM Activities in Learning Science" exhibited the highest consistency ($\alpha = 0.934$), followed by "Influence in Learning Mathematics" ($\alpha = 0.911$), and "Influence to Pursue Study" ($\alpha = 0.861$).

4.2.3 Normality Test

Table 4.9: Normality Test

Variable	Skewness
Influence of STEM Activities to Pursue Study	-0.907
Influence of STEM Activities in Learning Science	-0.786
Influence of STEM Activities in Learning Mathematics	-0.575

The Normality test results shown in Table 4.9 show skewness values for all three variables ranging from -0.907 to -0.575. These values suggest an approximately normal distribution of the data, as they fall within the acceptable range of -2 to +2 (Hair et al., 2010).

4.2.4 Mean Score of Agreement

Table 4.10: Level of Agreement of STEM Activities Motivation to Pursue Studies in Science and Mathematics (adapted from Moidunny (2009))

Mean Score	Interpretation
1.00 – 1.80	Strongly disagree
1.81 – 2.60	Disagree
2.61 – 3.20	Moderately agree
3.21 – 4.20	Agree
4.21 – 5.00	Strongly agree

The mean score for each variable is determined by dividing the total scores by the number of respondents. These mean scores are then classified using the interpretation scale presented in Table 4.10, which is adapted from Moidunny (2009).

Table 4.11 tabulates the mean scores for all measured variables, indicating that students generally "Agree" that STEM activities have a positive impact across all categories. The highest mean score was recorded for the category "Influence of STEM Activities to Pursue Study" (Mean = 4.0410), whereas "Influence in Learning Mathematics" registered the lowest mean score (Mean = 3.5840).

Table 4.11: Mean Score According to Influence of STEM Activities in Pursuing Studies and Learning Science and Mathematics

Variable	Mean Score	Level
Influence of STEM Activities to Pursue Studies in Science Stream Education	4.0410	Agree
Influence of STEM Activities in Learning Science	3.7607	Agree
Influence of STEM Activities in Learning Mathematics	3.5840	Agree

4.2.5 Influence of STEM Activities in Pursuing Science Stream Education

Table 4.12: Influence of STEM Activities in Pursuing Science Stream Education

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
My experience of joining STEM activities helps me to develop skills relevant to STEM careers.	0 (0.0%)	2 (5.1%)	9 (23.1%)	19 (48.7%)	9 (23.1%)	3.90	0.821
STEM activities provide me with relevant subject knowledge as the preparation to pursue science stream education.	0 (0.0%)	2 (5.1%)	7 (17.9%)	19 (48.7%)	11 (28.2%)	4.00	0.827
STEM activities can inspire me to pursue science stream education.	1 (2.6%)	1 (2.6%)	7 (17.9%)	17 (43.6%)	13 (33.3%)	4.03	0.932
My parents encouraged me to pursue science stream education.	1 (2.6%)	1 (2.6%)	7 (17.9%)	10 (25.6%)	20 (51.3%)	4.21	1.005

Career opportunities encourage me to pursue science stream education.	0 (0.0%)	1 (2.6%)	8 (20.5%)	17 (43.6%)	13 (33.3%)	4.08	0.807
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Table 4.12 lists descriptive statistics for all individual items concerning the influence of STEM activities on the pursuit of further study. This analysis revealed a high level of agreement, signifying a strong perceived influence on students' inclination toward advanced education. The mean scores for all items fell within the 'Agree' range (3.21–4.20), specifically varying between 3.90 and 4.21. The item exhibiting the strongest agreement ($M = 4.21$, $SD = 1.005$) was "My parents encouraged me to pursue science stream education," which is at the threshold of the "Strongly agree" category. Furthermore, the perceived value of STEM activities in developing skills essential for STEM careers also garnered a high mean score of 3.90 with a standard deviation of 0.821.

4.2.6 Influence of STEM Activities in Learning Science

Table 4.13: Influence of STEM Activities in Learning Science

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
I feel more confident in learning Science now.	1 (2.6%)	3 (7.7%)	7 (17.9%)	16 (41.0%)	12 (30.8%)	3.90	1.021
I find Science easier to understand now.	1 (2.6%)	4 (10.3%)	11 (28.2%)	13 (33.3%)	10 (25.6%)	3.69	1.055
I understand how Science is	2 (5.1%)	1 (2.6%)	4 (10.3%)	18 (46.2%)	14 (35.9%)	4.05	1.025

Table 4.13 details the descriptive statistics on the influence of STEM activities on Science learning. Most statements indicated an 'Agree' level, with the highest agreement observed for "Enjoy learning Science more than before" (M = 4.10, SD = 0.882) and "Understand how Science is useful in daily life" (M = 4.05, SD = 1.025). Conversely, the item "I am more likely to explore Science topics on my own because of STEM activities" received the lowest mean score (M = 3.15, SD = 1.182), which falls within the 'Moderately agree' range (2.61 – 3.20).

4.2.7 Influence of STEM Activities in Learning Mathematics

Table 4.14: Influence of STEM Activities in Learning Mathematics

Items	5-Point Likert Scale					Mean	SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
I feel more confident in learning Mathematics now.	0 (0.0%)	6 (15.4%)	10 (25.6%)	11 (28.2%)	12 (30.8%)	3.74	1.069
I find Mathematics easier to understand now.	4 (10.3%)	3 (7.7%)	8 (20.5%)	14 (35.9%)	10 (25.6%)	3.59	1.251
I understand how Mathematics is useful in daily life.	0 (0.0%)	3 (7.7%)	11 (28.2%)	17 (43.6%)	8 (20.5%)	3.77	0.872
I enjoy learning Mathematics	1 (2.6%)	4 (10.3%)	9 (23.1%)	12 (30.8%)	13 (33.3%)	3.82	1.097

more than before. I am excited to answer more questions related to Mathematics.	5 (12.8%)	4 (10.3%)	11 (28.2%)	10 (25.6%)	9 (23.1%)	3.36	1.308
I would recommend STEM activities related to Mathematics to my friends.	4 (10.3%)	2 (5.1%)	11 (28.2%)	13 (33.3%)	9 (23.1%)	3.54	1.211
I feel that STEM activities related to Mathematics should be done more often in school.	4 (10.3%)	4 (10.3%)	10 (25.6%)	12 (30.8%)	9 (23.1%)	3.79	0.951
I would like to take part in more STEM activities related to Mathematics.	4 (10.3%)	4 (10.3%)	2 (5.1%)	16 (41.0%)	15 (38.5%)	3.46	1.253
I am more likely to explore Mathematics topics on my own because of STEM activities.	5 (12.8%)	8 (20.5%)	9 (23.1%)	13 (33.3%)	5 (12.8%)	3.18	1.211

Table 4.14 presents the descriptive statistics for the influence of STEM activities on learning Mathematics, revealing that most related items also fall within the 'Agree' range. The highest mean score was found for the statement "I enjoy learning Mathematics more than before" ($M = 3.82$, $SD = 1.097$), indicating a strong level of agreement. High agreement was also observed regarding understanding how Mathematics is useful in daily life ($M = 3.77$, $SD = 0.872$). Conversely, similar to the science variable, the lowest mean score ($M = 3.18$, $SD = 1.211$) was associated with "I am more likely to explore Mathematics topics on my own because of STEM activities," which is only marginally within the 'Moderately agree' range.

4.2.8 Open - Ended Questions

QUESTION 1

How do STEM activities make Science and Mathematics more fun for you?

Students opined that STEM activities that involve practical, hands-on, and interactive experience, such as conducting experiments and working on real-world projects can enhance their enjoyment of Science and Mathematics. Another source of enjoyment is the ability to see the real-life application of scientific and mathematical concepts, making the subjects feel more relevant and meaningful.

QUESTION 2

What kind of STEM activities help you understand Science and Mathematics better?

The feedback indicates that the most effective STEM activities for better understanding Science and Mathematics are those that are practical, hands-on, and involve real-world application or problem-solving. Students also highlighted that experiments and projects are the most helpful, specifically citing activities like robotics, programming/coding, creating models, and designing simple machines. Additionally, other activities such as competitions (e.g., solar cars, water rockets), exhibitions, workshops, and group collaboration were also noted as being helpful for deepening their comprehension of Science and Mathematics.

QUESTION 3

Do STEM activities make you more interested in Science and Mathematics? Why or why not?

Based on student feedback, STEM activities are overall very effective in increasing their interest in Science and Mathematics. The majority stated that these activities make them more interested due to their interactive, fun, and hands-on nature of the activities, allowing them to explore concepts through application and challenge their minds. However, a small percentage of students stated the activities did not increase their interest, with the main reasons being that the activities were too difficult to understand or too complicated, along with complaints that not all provided STEM activities were enjoyable or relevant to their studies.

QUESTION 4

How can the use of technology in STEM activities be improved at your school?

Students strongly suggested that schools should acquire more digital tools such as tablets, robotics kits, programming software, and online simulation platforms to ensure hands-on experience. Students also suggested more frequent access to existing facilities, specifically by using the computer lab more often and providing internet access for research and learning. Students believe technology use would improve if the school organized more STEM activities or competitions and encouraged application-based projects that actively require the use of technology.

QUESTION 5

What kind of STEM activities do you wish to engage in more?

Students expressed a strong desire to engage more frequently in practical, application-based STEM activities, with the most popular requests being for more robotics projects, coding or programming challenges, and a greater number of hands-on experiments. There is also a clear wish for the school to organize more large-scale events such as STEM competitions, exhibitions, and science fairs to make learning more engaging. Students also specifically mentioned wanting to delve deeper into activities related to Chemistry and Physics, and to have more opportunities for collaboration and learning outside the classroom setting.

4.3 FEEDBACK FROM TEACHERS

QUESTION 1

What challenges do you face when implementing STEM activities at your school, and how do you overcome them?

Implementing STEM activities faces several significant obstacles. A primary category of challenges involves resource limitations, notably a lack of necessary resources and tight financial constraints, further compounded by difficulties in time management. Teachers also encounter technical barriers, specifically inadequate specialized knowledge, particularly in fields such as coding and wiring, and a shortage of suitable reference modules to guide them. Moreover, student-related issues, including low confidence and the perception that Science and Mathematics subjects are inherently difficult, contribute to the complexity of successfully delivering STEM initiatives.

QUESTION 2

In your experience, what types of STEM activities are most effective in increasing students' interest in Science and Mathematics?

To effectively boost student engagement in Science, Technology, Engineering, and Mathematics (STEM), the most successful activities are hands-on and clearly linked to real-world scenarios. Educators noted that learning experiences outside the typical classroom, coupled with collaborative projects involving universities and STEM bodies, are highly valuable. Key activities, such as designing and testing models and participating in coding exercises, were specifically noted for making STEM subjects more accessible and interesting to students.

QUESTION 3

Can you share any specific examples where a STEM activity significantly impacted a student's motivation to pursue study in a STEM-related field?

STEM activities were shown to be effective in fostering student initiative and interest, with teachers sharing specific examples. These included students independently participating in the NASA Space App Competition and demonstrating sustained progress over several years. A one-day visit to the UNIMAS STEM Carnivale was also highlighted as impactful, offering students immersive exposure. Although some respondents could not provide specific examples immediately, the shared highlights strongly suggest that external competitions and university-organized events are crucial motivators for students to pursue STEM-related fields.

QUESTION 4

What specific changes would you suggest to improve the effectiveness of STEM activities in your school?

Key recommendations for enhancing STEM activities center on improving curriculum integration so students can better link theoretical knowledge with practical application. Several logistical improvements were also proposed, specifically dedicating more time in the school schedule for STEM projects and alleviating the administrative reporting workload on teachers, which would enable them to concentrate more on teaching. Though some respondents offered no suggestions currently, the overarching goal is to cultivate an environment that is more conducive to and simplified for STEM education.

QUESTION 5

In your opinion, what role do parents play in supporting students' interest in pursuing studies in STEM fields?

Parental engagement is crucial for cultivating students' interest in STEM. Teachers emphasized the need for parents to create a supportive environment and consistently motivate their children. This support should involve proactively recognizing their children's STEM talents and providing extensive exposure to the field. Additionally, parental support is vital in a practical sense, including offering financial aid, resources, and time, and actively participating in school-organized STEM activities such as exhibitions and competitions, thereby strengthening the impact of student and educator efforts.

QUESTION 6

Please share any additional comments or insights regarding the influence of STEM activities on student motivation that were not covered in this questionnaire.

STEM activities were noted by teachers as being inherently inclusive, enabling students from various backgrounds and with diverse abilities to contribute uniquely, such as through designing, constructing, or presenting concepts. To boost student motivation and accountability, it was proposed that individual STEM projects should be mandatory components of final assessments. Nevertheless, significant obstacles persist, notably the restricted availability of technology, such as computers, which impedes students' full participation in and benefit from these activities.

QUESTION 7

What additional resources would help improve STEM activities in your school?

Improving STEM activities requires more financial and administrative support from school/district levels for materials and competition transport. Teachers also requested collaboration with external bodies, expert visits, curated lists of low-cost, high-engagement activities, and professional development (e.g., coding) to equip more educators.

4.4 DISCUSSION

Findings from the quantitative analysis show that STEM activities have a positive influence on the primary school students' inclination towards learning Science and Mathematics. Their regular participation in STEM activities are motivated by the fact that these activities help to enhance their comprehension of Science and Mathematics beyond the boundaries of the classrooms. Students are attracted to hands-on experiments and projects like water rockets, robotics, simple machines, big bubble activities, and model building, which make abstract concepts more tangible and engaging. compared to conventional learning. Secondary school students find that STEM activities inspire them to pursue Science stream education. Apart from encouragement from parents, STEM activities provide them with the relevant knowledge as preparation to pursue further education in Science, and prospective careers in STEM-related fields.

Feedback from the qualitative analysis highlights findings which include key challenges, effective practices, the role of parents and necessary structural support for implementing STEM activities. The feedback provides us information to devise a framework for improvement of future activities.

Challenges in Implementing STEM Activities

From the students' perspectives, some students find STEM challenging due to lack of confidence in Science and Mathematics; logistical constraints, including a general lack of resources and time management. Teachers cited a lack of knowledge and tech support in specific areas, for example computer coding and mechanical model assembly. There is still a need for reference modules, and bigger financial allocation for schools. At the same time, wider collaboration with external bodies (such as universities, colleges or NGOs), in building and testing models, and coding exercises may assist to overcome these constraints.

Effectiveness of STEM Activities

Many agree that the most effective STEM activities for better understanding of Science and Mathematics are those that are practical, hands-on, and involve real-life applications or problem-solving. Students also highlighted that experiments and projects are the most helpful,

specifically citing activities like robotics, programming/coding, creating models, and designing simple machines. Additionally, other STEM-related activities such as competitions (e.g., NASA Space App Competition), exhibitions (e.g., UNIMAS STEM Carnivale, Karnival STEM DUN N8), workshops, and group collaboration were also noted as being helpful for deepening their comprehension of Science and Mathematics. the responses provided concrete instances of boosting student motivation. It was also suggested that STEM activities be integrated into the present school curriculum and timetable to help students connect theoretical knowledge with practical application more effectively.

The Role of Parents

The role of parents is crucial in providing an encouraging environment at home. They are also expected to provide active support by participating in school-based STEM events such as STEM carnival, exhibitions and competitions. While parents may contribute to schools in various capacities, including finance, labour, and material support, it is important for them to acknowledge and support their children's talent and interest in STEM.

Structural Support for Implementation of STEM Activities

Findings from this study highlighted the inclusivity of STEM, noting that the activities encourage students of different abilities and backgrounds, allowing them to contribute through designing, building, or presenting creative ideas. This study showed that STEM activities enhance the enjoyment of Science and Mathematics primarily by transforming learning into a practical, hands-on, and interactive experience, such as conducting experiments and working on innovative projects, which moves beyond passive reading and writing. This direct engagement increases student interest, makes Science and Mathematics more fun and challenging, and allows them to explore new ideas. Based on the findings from this study,, future preferences lean towards innovative, tech-integrated projects that blend Science, Math, and practical application. In other words, wider usage of technology in STEM activities which centers around three main areas - increasing the availability of digital resources, providing more consistent access and opportunities, and expanding activity types. Presently, there are constraints notably the limited availability of personal computers and technology resources made available for schools. At the same time, schools require sufficient financial support for materials and transportation to STEM-related events (e.g. competitions, workshops,

exhibitions) and general administrative support from the school or district level. Improving STEM activities also necessitate professional development courses and exposure in technical areas relevant to STEM education for teachers.

5.1 INTRODUCTION

These mixed methods research comprehensively investigated the influence of ongoing STEM activities on school student motivation and enrolment intent within the Dewan Undangan Sarawak (DUN) N.8 Satok constituency, culminating in the development of a strategic framework for program enhancement. The study employed a triangulation of quantitative data from primary and secondary students and qualitative insights from both students and teachers to address four specific research objectives. The research involved 79 school students (n = 39 primary school, n=39 secondary school) from 5 schools and 10 STEM teachers in N.8 Satok constituency.

5.2 SUMMARY OF KEY FINDINGS

The study successfully achieved its objectives, yielding strong evidence regarding the positive impact and structural requirements for effective STEM program implementation:

5.2.1 Objective 1: Impact on Primary Student Motivation

STEM activities were found to positively influence upper primary school students' motivational beliefs in learning both Science and Mathematics. Students reported high levels of excitement and enjoyment, with mean scores consistently falling within the "Agree" range for motivation, confirming that hands-on experiences, collaborative group work, and the integration of technology make these subjects more tangible and engaging than conventional learning methods.

5.2.2 Objective 2: Influence on Secondary Student Enrolment

Secondary school students generally agreed that participating in STEM activities inspired them to pursue Science stream education. Beyond peer influence, the factors driving this inclination included parental encouragement, the acquisition of relevant knowledge as preparation for tertiary education, and an understanding of the prospective career opportunities in STEM-related fields.

5.2.3 Objective 3: Teacher Perspective on Influence

Secondary school teachers confirmed that practical, hands-on activities, especially those involving external collaborations (e.g., university visits, competitions), are the most effective in boosting students' interest in Science and Mathematics. Teachers also noted that STEM activities inherently promote inclusivity, allowing students of diverse abilities to contribute through designing, building, or presenting.

5.2.4 Objective 4: Development of a Framework for Enhancement

This framework is based on student and teacher feedback regarding effective practices, challenges, and necessary structural support for organizing sustainable and impactful STEM programs. The framework consisted of 5 pillars that serves as a guideline for conducting and organising STEM activities or programs in schools.

Pillar 1. Program Content and Design

- **Focus on Practical and Hands-on Activities**
 - Design activities that involve practical, hands-on, and interactive experiences, such as conducting experiments, working on real-world projects, and collaborative group work.
 - Utilize specific projects, including water rockets, robotics, simple machines, big bubble activities, model building, hydrogen activities, and coding exercises.
 - Ensure activities link theoretical knowledge to real-life applications to make subjects feel more relevant and meaningful.
 - Promote inclusivity, enabling students of diverse abilities and backgrounds to contribute (e.g., through designing, building, or presenting creative ideas).
- **Engage in External Exposure**
 - Organize learning experiences outside the typical classroom.
 - Include participation in competitions (e.g., solar cars, NASA Space App Competition), exhibitions (e.g., UNIMAS STEM Carnivale), and workshops to provide immersive exposure.
- **Integrate Technology for Engagement**
 - Incorporate interactive computer games, quiz games, and multimedia tools (e.g., TV monitors) to maintain student interest and clarify concepts.

- Focus on application-based projects that actively require the use of technology, such as robotics projects and programming/coding challenges.

Pillar 2. Structural and Administrative Support

- **Curriculum and Scheduling**

- Integrate STEM activities into the core school curriculum and allocate dedicated time in the school timetable to help students connect theoretical knowledge with practical application more effectively.
- Dedicate more time in the school schedule for STEM projects.
- Alleviate the administrative reporting workload on teachers so they can concentrate more on teaching.

- **Resource Allocation and Technology Access**

- Provide substantial financial and administrative support from the school and district levels.
- Allocate funds for acquiring essential digital tools, including more computers, laptops, tablets, and robotics kits.
- Improve infrastructure by providing faster and better internet connectivity.
- Increase consistent access to existing facilities, such as using the computer lab more often.

Pillar 3. Teacher Professional Development

- **Specialized Knowledge Training**

- Provide professional development courses and exposure in technical areas relevant to STEM education, such as computer coding and mechanical model assembly.
- Address inadequate specialized knowledge that teachers may have in technical fields.

- **Instructional Resources**

- Provide curated lists of low-cost, high-engagement activity ideas to reduce teacher preparation time and overcome knowledge gaps.
- Develop suitable reference modules to guide teachers in implementing new initiatives.

Pillar 4. Stakeholder Mobilization

- **Parental Engagement**

- Actively engage parents to create a supportive and encouraging environment at home.
- Encourage parents to proactively recognize and support their children's STEM talents.
- Advise parents to provide practical support, including financial aid, resources, and time.
- Encourage parental participation in school-organized STEM events such as exhibitions and carnivals.

- **External Collaboration**

- Actively seek wider collaboration with external bodies, including universities, colleges, and NGOs, to support building and testing models and coding exercises.

Pillar 5. Assessment and Accountability

- **Mandatory Projects**

- To boost student motivation and accountability, consider making individual STEM projects mandatory components of final assessments.

The summary of the framework is visualised in Figure 13. This framework should guide the implementation or conduct of any STEM activities or programs in schools.

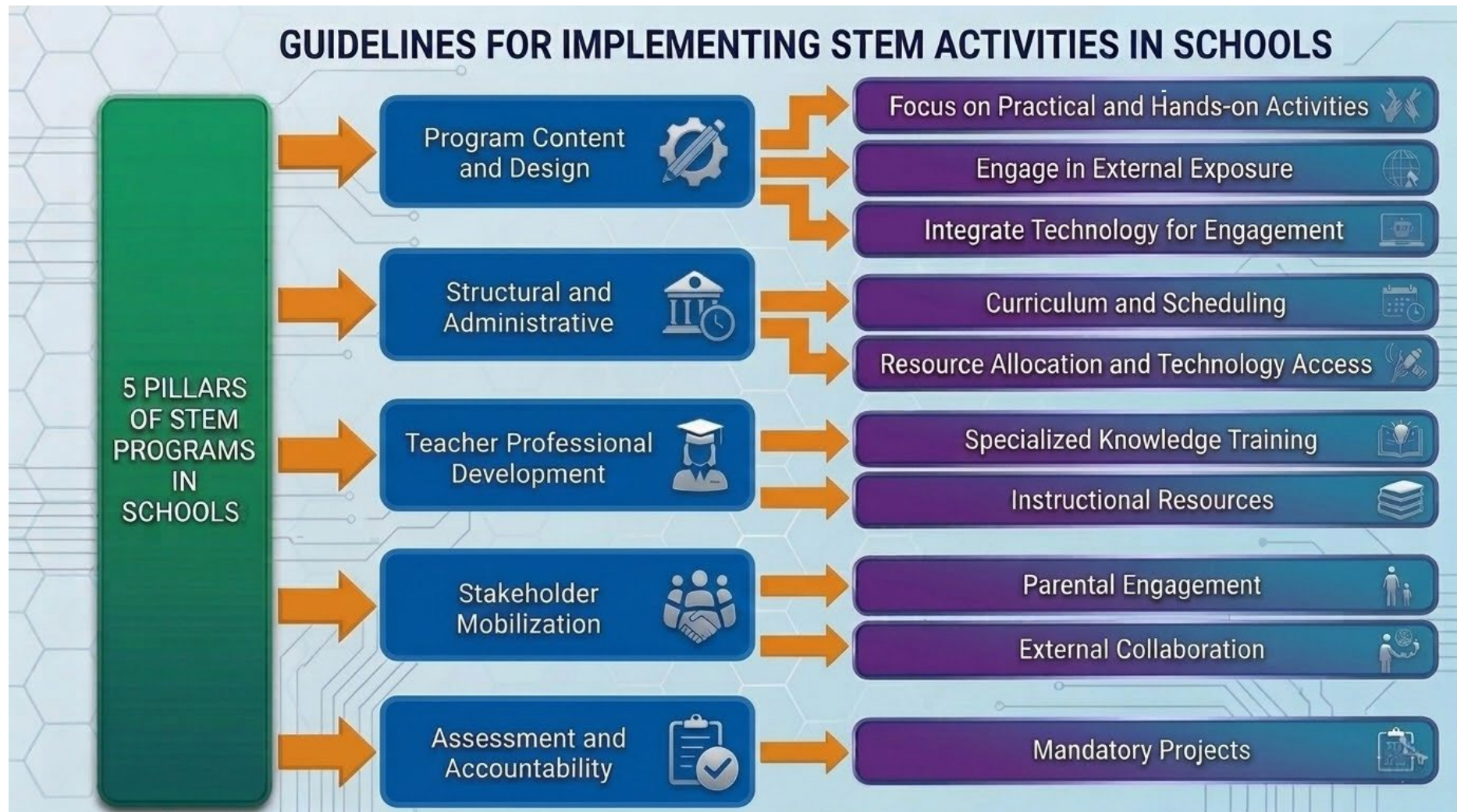


Figure 5.1: Framework for Implementing STEM Activities in School

5.3 IMPLICATIONS AND CONTRIBUTIONS

This research contributes significantly to the existing body of knowledge across theoretical, pedagogical, and policy domains, particularly within the Sarawak context.

- **Policy Relevance:** The findings directly support Sarawak’s strategic human capital development goals, including the post-COVID-19 Development Strategy (PCDS) 2030, by providing evidence-based recommendations to increase student participation and competency in technical fields. Clarifying the motivational factors for students in DUN N8 Satok offers localized, context-relevant data to guide targeted interventions and support equitable STEM development, especially in underserved areas.
- **Pedagogical Insight:** The study emphasizes the power of experiential learning, demonstrating that enjoyment and relevance are critical psychological drivers for sustained motivation in STEM. The preference for practical, real-world projects over abstract classroom work guides educators and curriculum developers toward instructional design that fosters critical thinking, problem-solving, and creativity.
- **Theoretical Contribution:** The research consolidates evidence supporting the notion that external factors—specifically strong parental support and exposure to career relevance—are essential for transitioning student interest into concrete educational pathways, thereby enriching the understanding of STEM motivation theories within the Malaysian educational system.

5.4 RECOMMENDATION FOR FUTURE RESEARCH

Based on the challenges and successes identified in the implementation of STEM activities, the following recommendations are proposed to enhance the effectiveness and sustainability of these programs:

Recommendations for Practice and Policy:

- **Increase Resource Allocation:** Schools require substantial financial and administrative support from the school and district levels, specifically for acquiring more digital tools (e.g., computers, tablets, robotics kits) and covering logistics, such as transportation for students attending external competitions and exhibitions.

- **Curriculum Integration and Scheduling:** STEM activities should be integrated into the core school curriculum and given dedicated time in the school timetable to help students effectively connect theoretical knowledge with practical application.
- **Enhance Teacher Professional Development:** There is a crucial need for professional development courses that equip educators with specialized knowledge, particularly in technical fields like computer coding and mechanical model assembly. Teachers also require curated reference modules and low-cost, high-engagement activity ideas to reduce preparation time and overcome knowledge gaps.
- **Strengthen External Collaboration:** Schools should actively seek wider collaboration with external bodies, including universities, colleges, and NGOs, to facilitate hands-on learning, expert visits, and larger-scale events that provide immersive exposure for students.
- **Mobilize Parental Support:** Stakeholders should actively engage parents, encouraging them not only to provide financial and material resources but also to proactively recognize and support their children's STEM talents by participating in school-based activities like exhibitions and carnivals.

Recommendation for Future Research Integrating AI Areas:

Based on the comprehensive findings of this research—which investigated the influence of STEM activities on student motivation, identified implementation challenges, and developed a five-pillar framework for program enhancement—the research can be effectively carried forward by integrating specific AI (Artificial Intelligence) research areas.

- **Evaluating AI-Specific Pedagogies:** Compare the impact of AI tool-integrated STEM activities (e.g., machine learning projects) versus traditional hands-on activities on student motivation and self-efficacy. Measure the effect of early AI concept exposure (data literacy, algorithmic thinking, ethics) on students' interest in computing and engineering.
- **Developing AI-Focused Teacher Professional Development:** Conduct longitudinal studies on new PD programs to build teachers' competency in AI/advanced coding, addressing the current challenge of inadequate specialized knowledge. Correlate

teacher AI literacy with student interest and enrollment in upper science streams, enhancing the **Teacher Professional Development** pillar.

- **Assessing AI's Role in Bridging the Digital Divide in Sarawak:** Quantify equitable access and effective utilization of AI learning tools (software, robotics kits) between urban and rural schools (e.g., DUN N8 Satok), building on findings of passive digital usage. Analyze low-resource AI initiatives to overcome connectivity/availability limitations, informing the **Resource Allocation** pillar.
- **Aligning AI Education with Workforce Readiness and PCDS 2030:** Research how AI-related STEM activities influence students' perceived career relevance, focusing on Sarawak's high-tech future and PCDS 2030. Evaluate industry/university collaborations that expose students to real-world AI applications (e.g., geospatial tech, IoT in agriculture).
- **Quantifying the Framework's Long-Term Impact:** After framework implementation, track the long-term impact on students' actual enrollment in tertiary AI and data science pathways.

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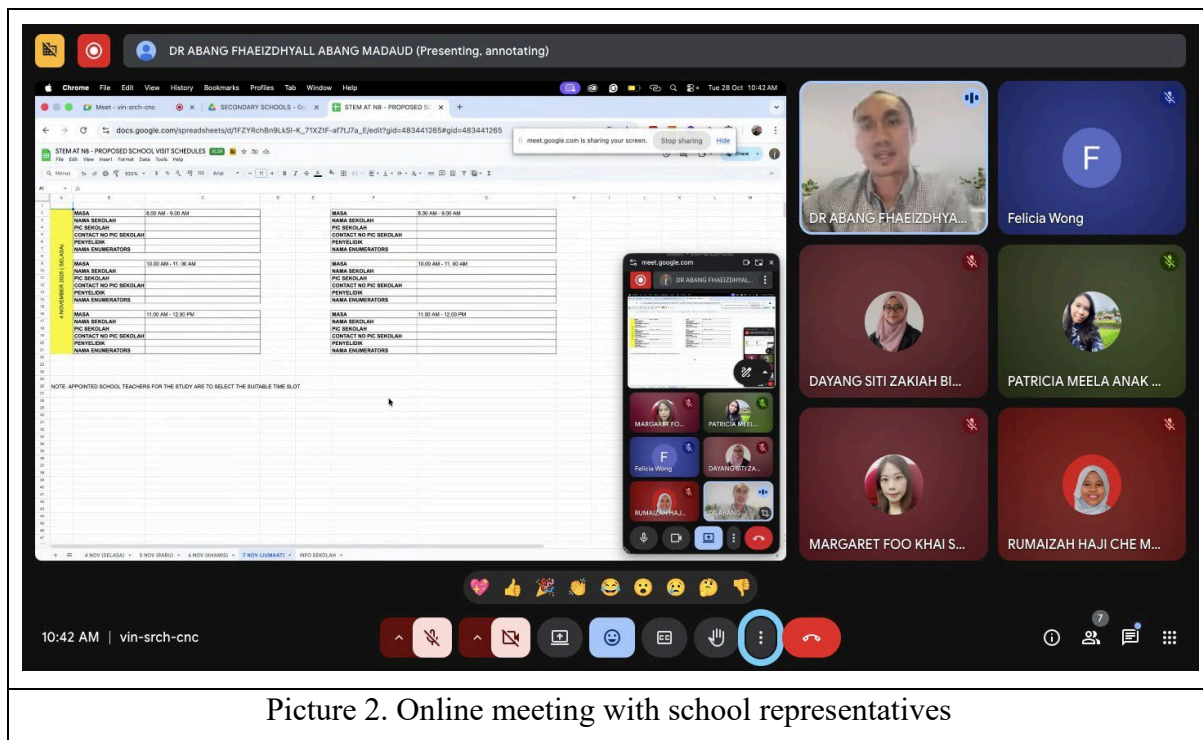
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APPENDICES



Picture 1. Discussion with the Principal (SMK Batu Kawa)



Picture 2. Online meeting with school representatives



Picture 3. Handing over the survey to Guru Besar (SK Merpati Jepang)



Picture 4. Discussion with the Principal (SMK St. Joseph)



Picture 5. Focus Group Discussion with the students (SMK Batu Kawa)



Picture 6. Focus Group Discussion with the students (SMK St. Joseph)



Picture 7. YB Dato Sri Roland Sagah Wee In, accompanied by UiTM Sarawak branch Rector, Prof. Firdaus Abdullah listening to the students' explanation and demonstration during the *Pertandingan Inovasi STEM Kota Samarahan* on 15 April 2025 in Dewan Jubli, UiTM Samarahan Campus.



Picture 8. Group Photos with the Winners of the *Pertandingan Inovasi STEM Kota Samarahan*

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FACTORS INFLUENCING STUDENTS' INTENTION TO PURSUE STUDY IN SCIENCE STREAM EDUCATION

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Picture 9. Accepted paper for Asian Journal of Social Science Research (AJSSR) 2026

