INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

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To Link this Article: http://dx.doi.org/10.6007/IJARPED/v12-i2/16825 DOI:10.6007/IJARPED/v12-i2/16825

Received: *08* February 2023, ***Revised:*** *12* March 2023, ***Accepted:*** *28* March 2023

Published Online: *15* April 2023

In-Text Citation: (Idris & Bacotang, 2023)

To Cite this Article: Idris, R., & Bacotang, J. (2023). Exploring STEM Education Trends in Malaysia: Building a Talent Pool for Industrial Revolution 4.0 and Society 5.0. *International Journal of Academic Research in Progressive Education and Development*, *12*(2), 381–393.

Vol. 12(2) 2023, Pg. 381 - 393

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Exploring STEM Education Trends in Malaysia: Building a Talent Pool for Industrial Revolution 4.0 and Society 5.0

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Abstract
In Malaysia, Science, Technology, Engineering, and Mathematics (STEM) education is becoming increasingly important in the current industrial revolution 4.0 and society 5.0 era. This study aims to investigate the current STEM education trends in Malaysia, the benefits of pursuing STEM careers in the future, and the need to build a talent pool to meet the demand of these two revolutions. This study highlights the various STEM education trends in Malaysia, including the incorporation of STEM-related subjects in the national curriculum and the promotion of STEM-related extracurricular activities. It also discusses the benefits of pursuing a career in STEM, such as higher earning potential and job security, as well as the importance of preparing a talent pool to meet the demand of the rapidly changing technological landscape. This study argues that Malaysia needs to focus on developing a robust STEM education system that can produce a workforce equipped with the necessary skills and knowledge to excel in the industries of the future. The study also highlights the role of policy makers, researchers, and educators in this process and proposes recommendations for enhancing STEM education in Malaysia. This study contributes to the literature on STEM education in Malaysia and provides valuable insights for policy makers, researchers, and educators.
Keywords: STEM Education, Industrial Revolution 4.0, Society 5.0, Talent Pool

Introduction

STEM education is the teaching and learning of science, technology, engineering, and mathematics, with an emphasis on combining these disciplines to solve real-world problems. It emphasizes the development of critical-thinking, problem-solving, and teamwork skills, and aims to prepare student for career in STEM fields. STEM education can take many forms, including project-based learning, inquiry-based learning, and problem-based learning, and can occur at all levels of education, from elementary school to higher education (National Science Foundation, 2020).

STEM education is about giving students the tools they need to solve complex problems, think critically, and innovate, not just teaching specific subjects or preparing students for specific careers. It is about giving students the ability to use their knowledge and skills to make a difference in the world. (National Academies of Sciences, Engineering, & Medicine, 2018). STEM education is an interdisciplinary approach that combines science, technology, engineering, and mathematics in order to solve complex problems and develop innovative solutions (Moore et al., 2014). STEM education is an interdisciplinary approach that combines the four disciplines of science, technology, engineering, and mathematics to create a rich and engaging learning experience that fosters students' critical thinking, problem-solving, and collaboration skills (Han et al., 2016).

On the other hand, STEM education, is an integrated, interdisciplinary approach to teaching and learning that emphasises the application of scientific, mathematical, and engineering concepts to real-world problems (Honey et al., 2014). STEM education is a way of teaching and learning that fosters innovation and creativity by integrating science, technology, engineering, and mathematics in a problem-based, real-world context (Smith & Moore, 2014). STEM education is a novel approach to teaching and learning that combines science, technology, engineering, and mathematics to encourage students to think critically, communicate effectively, and solve complex problems (Sanders, 2009). STEM education is an interdisciplinary approach that focuses on integrating science, technology, engineering, and mathematics to provide students with a deeper understanding of these subjects and to help them develop critical thinking, problem-solving, and collaboration skills (National Research Council, 2011).

According to an OECD report issued in 2020, Malaysia has made progress in implementing the Malaysia Education Blueprint (2013-2025), particularly in improving access to education and raising the quality of teaching and learning. However, the report acknowledges that much work remains to be done in areas such as early childhood education, technical and vocational education and training (TVET), and addressing inequality and disparities in educational outcomes. The Malaysia Education Blueprint 2013-2025 provides a comprehensive framework for reforming the country's education system, with an emphasis on improving student outcomes and preparing students for 21st-century challenges (OECD, 2020).

However, the government's commitment to nurturing and developing STEM talent in the country continues with the introduction of a Technical and Vocational Education and Training (TVET) system in 2011. Despite all efforts, there is still a low level of interest in STEM-related disciplines among students when compared to the planned ratio of 60:40, particularly at the secondary level. This situation has a cascading impact, with fewer students choosing to pursue STEM degrees at the tertiary level (both at universities and technical colleges) and a fall in STEM research and development if the numbers continue to dwindle at the postgraduate level (Hoon et al., 2022).

STEM Education in Malaysia

The Malaysia Education Blueprint (MEB) is a comprehensive education reform plan launched by the Malaysian government in 2013. The plan covers all levels of education, from preschool to higher education, and aims to transform the education system to better prepare students

for the challenges of the 21st century. The MEB was developed after a comprehensive review of the education system, which identified several key challenges, including low student achievement, unequal access to quality education, and a lack of alignment between the education system and the needs of the economy. The Malaysia Education Blueprint is organized around eleven strategic and operational shifts, which are designed to address these challenges and transform the education system. These shifts include:

Table 1
Malaysia Education Blueprint Agenda (2013-2025)

Wave	**Focus**
Wave 1 (2013-2015) Changing the system by supporting teachers and focusing on key skills	Improving teaching standards through targeted teacher consultation. Redesign of examination questions. Strengthening the quality of education STEM. Strengthening the mastery of language skills. Implementation of 1BestariNet and revision of IPG. Implementation of the District Transformation Program. Establish and strengthen principal selection criteria. Increasing preschool enrollment in middle schools through the campaign. Strengthening internship through increased collaboration with the private sector.
Wave 2 (2016-2020) Drives system upgrades	Implementation of the standard curriculum for secondary education (KSSM) and the standard curriculum for primary education (KSSR). Raise community interest and awareness of STEM. Pioneering program options to improve English language use. Strengthen programs for groups and promote ICT innovation. Improving guidance and support for teachers. Obtain international accreditation and strengthen the curriculum for the enrollment program.

	Expand vocational education options through implementation agreements with the private sector.
Wave 3 (2021-2025) Move towards excellence through increased operational flexibility	More innovation and opportunities to improve skills in Malay and English, as well as other languages. Implement ICT programs and innovations for special needs groups. Improving school-based management. Empowering the ministry and institutionalizing change.

(Source: Ministry of Education, 2013)

The Malaysia Education Blueprint is a long-term plan, spanning from 2013 to 2025, and includes several key milestones and targets. For example, the plan aims to improve student achievement in core subjects such as mathematics, science, and English, increase the number of students who complete secondary education, and improve the quality and relevance of vocational and technical education.

STEM education should focus on investigation and design, and emphasizes the importance of integrating these two practices, STEM education should go beyond the traditional approach of teaching separate subject isolation, and instead focus on developing student ability to use science and engineering practices to solve real-world problem. Simultaneously, emphasises the significance of equity and inclusion in STEM education and calls for increased efforts to ensure that all students have access to high-quality STEM education (National Academies of Sciences, Engineering, and Medicine, 2018).

The Malaysia Education Blueprint 2013-2025 is an ambitious plan for transforming the country's education system, with a focus on improving student outcomes and preparing students for success in the global economy. Key initiatives include the expansion of pre-school education, the development of a new assessment framework, and the promotion of innovative teaching and learning practices The STEM agenda method has been incorporated into the curriculum as a key component in its development and execution. In-depth approach to teaching and learning based on higher order thinking skills (HOTS) is the pedagogical emphasis in teaching. Inquiry-based learning, problem solving, contextual learning, collaborative learning, and project-based learning are all prioritised, all in accordance with the STEM approach. Given the Malaysian government's interest in STEM approaches at the school level, the government should ensure the implementation of curricula that match the features of a clear STEM integration (Bahrum et al., 2017).

As the demand for STEM graduates grows across industries, the trend towards STEM education is likely to continue, with more students becoming aware of the possible job options and growth prospects in these subjects. This movement towards STEM education benefits not only individual students, but also Malaysia's general economic growth and development, because a proficient and talented workforce in these subjects can drive innovation and improvement in a variety of sectors. According to Ministry of Education data

in 2022, the enrolment rate in STEM education in Malaysia was only 40.95 percent in 2021 (Ministry of Education, 2022). While this is a decrease from prior years, it also shows that there is still a long way to go in terms of encouraging more students.

As conclusion, the Malaysia Education Blueprint has played a significant role in shaping the development of STEM education in Malaysia. The blueprint acknowledges the significance of STEM education for Malaysia's future economic and social development and lays out a comprehensive plan to promote STEM education from primary to tertiary levels. The plan includes improving the quality of STEM teaching, enhancing industry-academia partnerships, increasing funding for STEM programs, providing career counselling services, and addressing gender biases in STEM education and careers.

Trends of STEM Education in Malaysia

The Malaysia Education Blueprint represents a significant effort to reform the country's education system, but there are still challenges to be addressed in areas such as early childhood education, TVET, and addressing inequality and disparities in educational outcomes. In Malaysia, the decrease in the number of students enrolled in the science stream 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).

Besides that, the Malaysia Education Blueprint has the potential to improve student outcomes and prepare students for success in the 21st century, but there are still challenges to be addressed in areas such as teacher quality, school leadership, and curriculum development. The low uptake of science-based subjects is not limited to Malaysia; it is a widespread phenomenon that includes countries such as the United States of America, where the National Science Board reports that the number of US high school graduates choosing to pursue a STEM-related field has steadily declined (Ong et al., 2017).

One of the main challenges of implementing STEM education in Malaysia is the lack of qualified and trained teachers who are able to effectively teach STEM subjects. According to Hoon et al (2018), many Malaysian teachers lack the necessary knowledge and skills to teach STEM subjects, which can lead to low student interest and performance. To address this issue, the quality of STEM teacher need to be improved to be achieving the high quality STEM education by training and professional development programmes be implemented (Nasri et al., 2020).

Another barrier is the scarcity of resources and facilities for STEM education in Malaysian schools. According to a study conducted by Ramli et al (2022), many schools lack basic laboratory equipment, materials, and infrastructure to support STEM education. At the same time, there is a gap between what teachers would ideally want the presence of technologically equipped classrooms, including a good internet connection and the facilities that are available, resulting in low technology implementation and a lack of teacher motivation to use technology in teaching and learning (Kamal et al., 2019). This can limit students' opportunities for hands-on learning and exploration, both of which are critical components of STEM education.

A lack of support from school administrators and policymakers was also identified as a challenge in the study, limiting the extent to which STEM education was prioritised and integrated into school curricula (Ismail et al., 2019). The study also discovered a lack of public awareness and understanding of STEM education, which contributed to a lack of support and interest in STEM education initiatives' implementation. Furthermore, cultural and societal factors may impede STEM education implementation in Malaysia. Abdul Ghani et al (2020) discovered that some Malaysian students and parents believe STEM subjects are difficult and irrelevant to their future careers. This can deter students from pursuing STEM education and reduce the number of students interested in these subjects (Halim et al., 2017).

According to Rauf et al (2019), the challenge of integrating STEM education across different subject areas in Malaysian schools is significant. While STEM education has been introduced as a cross-curricular approach in Malaysian schools, the study discovered that there is a lack of clarity and consistency in how STEM is integrated across different subjects. This has resulted in teacher and student confusion about what constitutes STEM education, as well as a lack of coordination and collaboration among teachers from various subject areas. A lack of student-centered, inquiry-based teaching methods was also identified as a challenge in implementing STEM education in Malaysian schools, according to the study (Jamal et al., 2017). The researchers discovered that many Malaysian teachers still use traditional, lecture-based teaching methods that do not engage students in hands-on learning.

Furthermore, Mohtar et al (2019) investigated the relationship between self-efficacy, and STEM interest among Malaysian secondary school students. The findings indicate that students' interest in life sciences-related occupations is influenced by their self-efficacy and career perceptions. Meanwhile, students' interest in physical science-based occupations is influenced solely by their self-efficacy and not by their impressions of the profession. Improving students' self-efficacy through STEM learning experiences is critical to maintaining students' enthusiasm in STEM careers. The study also discovered that self-efficacy was important in shaping students' interest in STEM. Students with higher levels of self-efficacy in STEM subjects, in particular, were more likely to express an interest in pursuing STEM careers.

In conclusion, the implementation of STEM education in Malaysia faces several challenges, including the lack of qualified teachers, limited resources and facilities, and cultural and societal factors. Addressing these obstacles will require a concerted effort from educators, policymakers, and society as a whole to promote and support STEM education in Malaysia. The table 2 show the findings of previous studies, which indicates five other factors that pose challenges in STEM education in Malaysia.

Table 2
Challenges in Implementing STEM Education in Malaysia

Researcher	Factor	Explanation
Markus et al (2021) Chin et al (2019)	Limited Resources	One of the most significant challenges in implementing STEM education in Malaysia is a lack of resources, including funding, technology, and infrastructure. Many schools do not have the necessary resources to provide quality STEM education to their students, which can limit the effectiveness of STEM education initiatives.
Mahmud et al (2018) Khalik et al (2019)	Teacher Training	Another challenge is the need to provide adequate training for teachers to deliver STEM education effectively. Many Malaysian teachers may lack the necessary knowledge or skills to teach STEM subjects and may require additional training to do so.
Ramli and Awang (2020)	Lack of Interest	There is a general lack of interest in STEM subjects among Malaysian students, making it difficult to engage and motivate them to pursue these fields. This could be due to a lack of awareness about potential STEM careers, as well as cultural and societal factors that discourage students from pursuing these fields.
Mustafa et al (2022)	Curriculum Alignment	There may be a misalignment between the STEM curriculum and the needs of the Malaysian economy and job market, limiting STEM education's relevance and ability to prepare students for the workforce.
Rahman and Halim (2022) Goy et al (2018)	Gender Gap	STEM education and careers have a gender gap, with fewer girls than boys pursuing these fields. This is a problem in Malaysia because it reduces the pool of potential talent and diversity in STEM fields. Efforts must be made to encourage and

Halim et al (2018)	support girls' participation in STEM education and careers.

STEM Career Interest

Increasing students' interest in STEM careers is one of the challenges in STEM education. According to Wang and Degol (2017), parental support, teacher encouragement, role models, and hands-on learning experiences all influence students' interest in STEM careers. The study also discovered that students' interest in STEM subjects correlates positively with their academic achievement in these subjects.

Gender and race or ethnicity are also important factors in STEM career interest, according to another study by (Xie and Shauman, 2018). The study discovered that girls and students from underrepresented racial/ethnic groups are less likely to express interest in STEM careers, and that this gender and racial (ethnic) gap is due in part to social and cultural factors like stereotypes and a lack of role models. In addition, Kamsi et al (2020) discovered that students' perceptions of the relevance and usefulness of STEM education to their future careers influence their interest in STEM careers. Students who perceived STEM education as more relevant and useful to their future careers were more likely to express interest in STEM careers.

Furthermore, studying the elements that contribute to STEM career interest may help to improve knowledge of how children learn STEM subject and provide direction in designing intervention and teacher education programmes. Halim et al (2018) study aimed to develop an instrument measure interest in STEM career and factor to influence STEM career among student in Malaysia. The factors revealed in this study can be used to build a model of interest in STEM occupations. These criteria will be used to guide future interventions targeted at increasing kids' interest in STEM jobs. Identifying the factors that contribute to STEM employment interest will also provide recommendations for demonstrating that exposing early secondary students to the engineering design process in integrated STEM education boosts their interest in those disciplines and related occupations. The intervention plan was also helpful in transitioning pupils from a moderate to a high level of interest in STEM (Shahali et al., 2016).

To summarise, increasing students' interest in STEM careers necessitates addressing a variety of factors such as parental support, teacher encouragement, role models, hands-on learning experiences, and addressing social and cultural factors such as stereotypes and lack of representation. Promoting the relevance and utility of STEM education in students' future careers can also help to increase their interest in STEM careers.

Connections of STEM Career Interest with Government Policy

The policy is known as the National STEM Transformation Plan, and it was introduced by the Ministry of Education in 2019. By providing students with the necessary skills and knowledge, the National STEM Transformation Plan aims to increase the number of students pursuing STEM education and careers. Meanwhile, students' interest in STEM jobs is hampered by a lack of knowledge and misconceptions about the field. Students who lack vocational identities and work information are more prone to question their career choices (Mahmud et al., 2022).

The policy sets out several strategies to achieve this, including increasing the number of STEM teachers, providing professional development opportunities for educators, and enhancing the curriculum to include more STEM-related content. Teachers must play a key role in efficiently and creatively implementing STEM curriculum in their classrooms. Most teachers have found this profession to be quite challenging, as they are expected to be informed and skilled in both STEM and creative areas (Amran et al., 2021).

By the way, to meet global economic problems and increase the country's resources, educators should be trained in STEM-related information in order to advance to the fourth industrial revolution (IR 4.0) and Society 5.0. STEM4ALL will begin a campaign during the Bett Asia Leadership Summit and Expo in 2019 to foster an inclusive culture of STEM education among Malaysians for marginalised kids with special needs, low income family and rural communities (Checa & Bustillo, 2020).

Furthermore, the Malaysia STEM Exploration Centre, the Malaysia Global Science and Innovation Advisory Council (GSIAC), and the Centre of Engineering Education (CEE) University Technology Malaysia are collaborating with other organisations to develop STEM education that can raise societal awareness (Sukumaran et al., 2021).

Aside from that, the Malaysian Ministries of Education (MOE) and Science, Technology, and Innovation (MOSTI) have launched strategic plans to increase student enrolment in Science, Technology, Engineering, and Mathematics (STEM) in order to develop a STEM-literate society with a high-quality and sufficient workforce. Institut Aminuddin Baki (IAB), the MOE's leadership development centre, has piloted a Science, Technology, Engineering, and Mathematics Executive Consultation (STEMEC) project as part of the Malaysia Educational Blueprint 2013-2025 (Foi & Kean, 2023).

Conclusions

As conclusions, STEM education in Malaysia has been experiencing a decline in student participation, which is not unique to Malaysia but is a widespread problem in many countries. The Malaysia Education Blueprint 2013-2025 and the National STEM Transformation Plan are two government policies designed to promote STEM education and careers among students. Despite these initiatives, more action is required to address the downward trend in STEM education participation and interest in STEM careers. A lack of qualified STEM teachers, a perception of STEM subjects as difficult and uninteresting, and a lack of exposure to STEM careers are all issues that must be addressed. Furthermore, investigating current STEM education advances in Malaysia is critical for developing a skilled workforce capable of leading innovation and advancement in the Fourth Industrial Revolution and Society 5.0. It is possible to ensure that the country remains competitive and relevant in an intricate and interconnected global scenario by implementing cutting-edge technologies and providing students with the necessary skills, understanding, and attitude. This research study provides insights and updates on the most recent trends in this subject, which can be useful to educators, policymakers, and other interested parties seeking to impact the future of education and employment.

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