



PRIMARY RESEARCH

'School Coders': An initiative to promote STEM education in building inclusive communities—case studies from schools in Malaysia

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Keywords

School coders
Stem education
Inclusive communities
Economic growth
Social development

Received: 12 January 2024**Accepted:** 6 March 2024**Published:** 21 April 2024

Abstract

'School Coders' is a unique Youth Hub initiative that stands out for its commitment to promoting STEM (science, technology, engineering, and mathematics) education in Malaysia. It is designed to build inclusive communities by empowering students from diverse backgrounds, including all races and ethnicities, irrespective of religion as well as social status, including people with disabilities from rural, urban, and indigenous communities. The initiative aims to foster a culture of creativity, critical thinking, and problem-solving, and empower students and educators through technology. It is implemented in schools across Malaysia, targeting primary and secondary-level students and educators, and is inclusive of students of all abilities, including those with special needs. The initiative utilizes a combination of curriculum-based coding education, hands-on activities, and practical projects to engage students in STEM learning. The program also emphasizes the importance of diversity and inclusion in the field of STEM, encouraging students to embrace diversity and foster an inclusive mindset. The "School Coders" initiative aims to address the disparities in STEM education by making it accessible to all students, regardless of their socio-economic background or geographical location (SDG 10). The program is implemented through partnerships with schools, local communities, government and non-government organizations, and industry experts to ensure a holistic approach to STEM education (SDG 17). It provides opportunities for students to develop their coding skills, explore STEM career pathways, and connect them with mentors from the industry (SDG 8). Furthermore, "School Coders" focuses on the capacity building of educators by providing professional development opportunities to enhance their pedagogical skills in effectively delivering STEM education (SDG 4). The initiative is working towards creating a sustainable ecosystem for STEM education in Malaysia by advocating for policy changes and fostering collaborations between academia, industry, and government agencies (SDG 17). The anticipated outcomes of the "School Coders" initiative include improved STEM literacy among students, increased participation of students from diverse backgrounds in STEM fields, and a more inclusive and equitable society. By promoting STEM education and inclusivity, "School Coders" aims to contribute to Malaysia's economic growth and social development by preparing the next generation of innovators and problem-solvers to thrive in the digital age.

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I. INTRODUCTION

Introducing coding to school students is a vital step in advancing engineering education. This fosters improved com-

putational skills and boosts higher education success. The effectiveness of integrating coding relies on school leaders' and teachers' beliefs in its value and their readiness for in-

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novative teaching. In the 1960s, coding aimed at transforming education by engaging schoolchildren [1]. LOGO software brought it to primary schools in the 1980s, only to fade within a decade [2]. Shifting the focus to skills like word processing and Internet searching led to its decline, but a resurgence came after 2010. Estonia, Greece, England, and Australia integrated computing into primary curricula, backed by age-appropriate tools and computational thinking development [3, 4].

In an exploratory study in the literature, a large-scale survey of 42 primary and secondary schools in Hong Kong reveals a growing trend of coding education in local schools with positive attitudes towards teaching and learning. Yet, challenges like teacher training and curriculum standardization still need addressing. The ability to code computer programs is considered an important part of literacy in today's society. Coding is a part of logical reasoning, representing one of the key skills of what is now called "21st-century skills" [5]. According to the Malaysia Education Blueprint 2013–2025, 1 in 5 Malaysian students don't complete secondary school, and 44% do not meet the minimum proficiency levels in reading. Also, 60% of Malaysian students do not meet the minimum requirements. More than two-thirds of students in the majority of underperforming schools in Malaysia come from challenging socioeconomic backgrounds.

Like numerous other nations, Malaysia acknowledges the significance of STEM education in equipping its young generation to a swiftly changing global landscape. The School Coders program took place in response to the requirement for enhanced STEM awareness and proficiency. This initiative is dedicated to motivating and enabling students, particularly those from underserved backgrounds, to embark on careers within STEM domains. The School Coders program is a groundbreaking endeavor designed to ignite and advance STEM (Science, Technology, Engineering, and Mathematics) education among Malaysian students.

Malaysia has been actively promoting digital literacy and technological innovation in recent years. Recognizing the importance of equipping students with coding skills from an early age, the government launched the 'School Coders' program in collaboration with tech industry partners. This case study highlights the program's objectives, strategies, impact, and the transformative changes it has brought to the Malaysian education landscape. This case study examines how this program has played a significant role in transforming the educational landscape in the country. This case study includes a summary of activities conducted on awareness development among high school students from:

- Sekolah Menengah Kebangsaan Warisan Puteri
- Sekolah Menengah Kebangsaan Kompleks KLIA
- Sekolah Menengah Kebangsaan Seremban Jaya
- Sekolah Menengah Kebangsaan Puteri
- Sekolah Menengah Kebangsaan Seri Pagi
- Sekolah Menengah Kebangsaan Dato' Shahardin

A. The 'School Coder' Program

One of the key questions in education is how to sustain students' interest to foster lasting intrinsic motivation. Imagine students engaged in an exciting coding activity like Scratch; some may lose interest quickly while others develop a lasting passion. Sadly, socio-economic factors deny many Malaysian children opportunities, hindering their potential. Our goal is to eliminate educational inequity and ensure every child's future is not limited by their background. Should all children learn coding, or just aspiring programmers? We believe coding is essential for everyone in today's information-driven world. Countries vary in their approach: Estonia starts programming at seven, while some nations integrate it across subjects.

The significance of coding competence and its societal impact is well recognized [6, 7] reports rising demand for coding skills across various professions, outpacing overall job market growth. [8] outlined three ways to learn coding: formal education (schools), non-formal (online, clubs), and informal (hackathons). Schools use resources from non-profits, governments, and companies, while clubs and projects with affordable tech like Raspberry Pi to teach coding.

The 'School coders' program was conceptualized in response to this increasing demand for tech-savvy professionals and the realization that coding skills have become fundamental to succeeding in a digitally evolving world. Launched in 2019 by YouthHub, the program aimed to introduce coding and programming concepts to primary and secondary school students across Malaysia.

'School coder' is an initiative aimed at bringing together parents, educators, students, the private sector and policymakers towards advancing equitable and inclusive STEM education for all. The objectives of the initiative "School coder" are to:

- To motivate the students towards ICTs & Programming: To create awareness among the students about the usefulness and importance of having ICT skills.
- To encourage interest in STEM: To foster curiosity and interest in science, technology, engineering, and mathematics among Malaysian students.
- To promote equity in education: To bridge the digital

divide and ensure equal access to quality STEM education across all regions, regardless of socioeconomic backgrounds. (SDG 10)

- To enhance digital literacy: To equip students with essential digital skills and competencies required in the digital age. (SDG 4)
- To develop problem-solving abilities: To nurture critical thinking and problem-solving skills through engaging and hands-on STEM activities. (SDG 8)
- To bridge the gap: To establish linkage through partnerships with schools, local communities, Govt and Non-Govt organizations and industry experts to ensure a holistic approach to STEM education. (SDG 17)

B. STEM Education in Malaysia to Build Inclusive Communities

Coding skills encompass problem-solving, logical and computational thinking, and design. [9] defines computational thinking as viewing the world as an algorithmic input-to-output process. This involves tackling problems with human cognition and computing power [10, 4, 11, 12]. These skills, along with computational thinking, are crucial in the 21st century, spanning problem-solving, critical thought, creativity, collaboration, and communication [13, 14]. Teachers worry about students' interest in STEM subjects. Maker culture can engage students in STEM learning. Maker activities differ globally. Events like European Maker Week and coding events aren't school-related, but schools could integrate them into curricula. Students can learn STEM's importance by solving real-world problems in these events.

Malaysia is rapidly industrializing and shifting towards a knowledge-based economy, requiring a competitive workforce with strong STEM skills. Yet, STEM education there is viewed as elitist and inaccessible, with around 70% of students disinterested due to overly theoretical teaching. Recent surveys show that merely a third of upper secondary students pursue science, and 44% pursue mathematics, while only 32% of tertiary students are in STEM courses. There has been a growing recognition of the need to make STEM education more inclusive in recent years. This has led to several initiatives aimed at increasing access to STEM education for all students, regardless of their background. One of the most important initiatives is the introduction of the STEM Masterplan 2025. This plan outlines several strategies for promoting STEM education in Malaysia, including developing new STEM-focused schools, introducing more STEM-related courses in universities, and providing more STEM scholarships. Another important initiative

is establishing the STEM Centre of Excellence (STEMCoE). This centre is responsible for coordinating and implementing the STEM Master Plan 2025. It also provides support to schools and teachers in developing STEM-rich learning environments.

In addition to these national initiatives, a number of local and community-based initiatives are working to make STEM education more inclusive. These initiatives include STEM clubs, after-school programs, and online resources. Efforts to boost inclusive STEM education in Malaysia yield positive results. Marginalized students engage in STEM, fostering diverse careers, yet further inclusivity is essential across all educational levels. Bridging the gender gap in STEM remains a priority.

Despite the challenges, the progress made in recent years is encouraging. With continued effort, Malaysia can make STEM education more inclusive and accessible to all students.

- There are several ways in which STEM education can build inclusive communities.
 - a. STEM education can help increase the participation of women and girls in STEM fields. This is important because women and girls are underrepresented in STEM fields, and their participation is essential for building a more inclusive society.
- STEM education can help promote diversity and inclusion in STEM fields. These fields are becoming increasingly diverse, and it is important to ensure that all students have the opportunity to participate in them.
- STEM education can help develop critical thinking and problem-solving skills. These skills are essential for solving the complex problems that we face as a society, and they are also essential for building inclusive communities.
- STEM education can help foster creativity and innovation. These qualities are essential for building a more innovative and inclusive society.

C. Program Impact and Outcomes

The 'School coders' program has profoundly impacted students, educators, and the nation as a whole.

1) *Increased digital literacy* : The program significantly increased digital literacy among students, enabling them to comprehend and use technology effectively.

2) *Enhanced problem-solving skills* : Coding projects and challenges sharpened students' problem-solving abilities, encouraging them to think critically and approach tasks methodically.

3) *Fostering innovation* : 'School coders' has nurtured a culture of Innovation, inspiring students to explore tech-based solutions to real-world problems.

4) *Career preparedness* : The program's graduates are better prepared for future careers in technology-related fields, giving Malaysia a competitive edge in the global job market.

5) *Economic growth* : The program's emphasis on nurturing tech talents has contributed to the growth of the local tech industry, attracting investments and fostering innovation-driven entrepreneurship.

D. Impact of School Coders Program in Overcoming Challenges

One of the major challenges that any developing country faces is the challenge of inclusivity. The school coder's program is expected to overcome these challenges by reducing:

1) *Gender disparities* : Historically, females have been underrepresented in STEM fields due to societal norms and biases. Specific initiatives can be launched to encourage girls and women to pursue STEM subjects and careers.

2) *Socioeconomic disparities* : Students from low-income backgrounds often need more access to quality STEM resources. Scholarships can be introduced to support underprivileged students in pursuing STEM degrees. NGOs should collaborate with the private sector to establish mentorship programs, guiding students from underrepresented groups.

3) *Regional disparities* : Rural and remote areas need more infrastructure and qualified educators for STEM education. Educational institutions can organize STEM workshops and camps for students from marginalized backgrounds as an outreach program. NGOs can deploy mobile labs to reach students in remote areas, offering hands-on STEM experiences.

Expected impact and outcomes of increased STEM education through implementation school coder's program:

4) *Increased female participation* : More girls and women pursued STEM, reducing gender disparities.

5) *Bridging socioeconomic gaps* : Underprivileged students gained access to quality STEM education, leveling the playing field.

6) *Fostering unity* : Inclusive STEM initiatives brought together students from different ethnic and cultural backgrounds, promoting social cohesion.

E. The Case Studies from Malaysia on Promoting STEM Education Through 'School Coder's' Program

The workshop began with an inspirational video about the importance of computer programming: "The rise in demand for technology-driven learning among the youth and its future.". This was followed by a speech from a school authority, who discussed the benefits of learning to code. Next was a speech about basic programming, covering topics such as why we need to learn code, the different programming languages, and how to get started.

The programming workshop began with participants learning the basics of Hour of Code, Scratch, HTML, CSS, Python, PHP, and C programming. This was followed by a QA session, where participants could ask questions about the material that had been covered. The workshop concluded with a certificate-giving ceremony and a closing gift.

Here is a more detailed breakdown of the activities that took place:

1) *Inspirational video for school programming* : This video showcased the benefits of learning to code and inspired participants to get started.

2) *Speech from school authority* : This speech discussed the importance of coding in today's world and how it can benefit students in their academic and professional careers.

3) *Speech about basic programming* : This speech covered the basics of programming, including what it is, why we need to learn it, and the different types of programming languages.

4) *Programming session* : This session provided participants hands-on experience with different programming languages. They learned the basics of Hour of Code, Scratch, HTML, CSS, Python, PHP, and C programming.

5) *QA session* : This session allowed participants to ask questions about the material that had been covered.

6) *Certificate-giving ceremony* : At the end of the workshop, participants received a certificate of completion.

7) *Closing gift* : Participants received a closing gift as a token of appreciation for their participation.

The workshop was a great success. Participants learned a lot about the basics of programming. They were inspired by the speakers and enjoyed the hands-on experience. The workshop was a valuable opportunity for participants to learn about the importance of coding and how it can benefit them in their future careers.



Fig. 1

46 students from SMK WARISAN PUTERI in two batches participated in the workshop. Some exciting topics were

widely discussed, including printing something using the C language or calculating something using this language.



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6

- 8) *Possible Challenges and Future Directions* :
- 9) *Sustaining Initiatives* : Ensuring the longevity of inclusive STEM programs and policies.
- 10) *Data Collection* : Enhancing data collection to measure the impact of these initiatives.
- 11) *Scaling Up* : replicating successful models across the country for widespread impact.

II. CONCLUSION

STEM education in Malaysia has proven to be a powerful tool for building inclusive communities. By allowing all students to learn about STEM subjects, STEM education can help break down stereotypes, promote diversity and inclusion, and develop critical thinking, problem-solving, creativity, and innovation skills. These are all essential quali-

ties for building a more equitable and just society. The concerted efforts of the government, educational institutions, NGOs, and the private sector have resulted in increased access to quality STEM education for all students, leading to greater social cohesion, economic growth, and innovation. Sustained commitment and collaboration will be crucial to furthering the cause of inclusivity through STEM education in Malaysia.

In Malaysia, a number of initiatives are working to make STEM education more inclusive. These initiatives are having a positive impact and are helping to create a more diverse and inclusive STEM workforce. With continued effort, Malaysia can make STEM education more inclusive and accessible to all students. STEM education can play a significant role in building inclusive communities.

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