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Evaluating the effectiveness of the S.M.A.R.T. community program in promoting stem interest: A case study of SK Terusan Tengah, Sabah, Malaysia

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Abstract
The S.M.A.R.T. STEM Community Program at SK Terusan Tengah aimed to enhance participants' knowledge, attitudes, and interest in STEM fields through hands-on activities, workshops, and community engagement. This study utilized a pre-test/post-test design and collected quantitative data through a survey with Likert-scale items. The results of the descriptive analysis revealed high mean scores for knowledge (4.50), attitude (4.64), and interest (4.52), indicating the effectiveness of the program in fostering a positive shift in participants' STEM engagement. Correlation analysis demonstrated strong positive relationships between knowledge, attitude, and interest, with significant interdependencies. The findings suggest that increasing participants' knowledge improves their attitudes and sparks their interest in STEM. This study highlights the importance of integrating experiential learning and community involvement in STEM programs to achieve sustained impact, advocating for future programs that combine these elements to nurture the next generation of STEM professionals.

Keywords: STEM Education, Community Engagement

Introduction

The importance of Science, Technology, Engineering, and Mathematics (STEM) education has gained significant attention in recent years due to its critical role in fostering innovation, economic development, and technological advancement. However, despite its global importance, the uptake of STEM disciplines, especially in rural and underrepresented areas, remains challenging. This issue is exacerbated by a lack of exposure to quality STEM programs that engage students in hands-on and collaborative learning experiences. The S.M.A.R.T. Community Program (Science, Mathematics, Action, Research, Technology), an educational initiative designed to address this gap, aims to enhance the interest and involvement of students in STEM by integrating practical activities and real-world problem solving. The program's multi-disciplinary approach focuses on providing students with exposure to a variety of STEM fields while cultivating critical thinking and problem-solving skills through action-based research.

Research has shown that community-based STEM programs can significantly influence students' attitudes, knowledge, and interest in STEM disciplines, particularly in rural or underserved communities. Programs like S.M.A.R.T. are essential in making STEM education more accessible and engaging, thereby bridging the gap between classroom learning and real-life applications [1]. In the context of SK Terusan Tengah in Sabah, Malaysia, the S.M.A.R.T. Community Program was implemented to promote STEM awareness and participation among school students and communities, an effort that aligns with national educational priorities in Malaysia [2]. Previous studies have highlighted the positive impact of STEM outreach programs in rural schools, where traditional educational resources may be limited [3]. These programs not only enhance students' understanding of STEM but also foster a sense of excitement and curiosity about the potential of science and technology to address real-world problems. This paper evaluates the effectiveness of the S.M.A.R.T. Community Program in promoting STEM interest among students at SK Terusan Tengah, Semporna, and other communities by examining changes in participants' knowledge, attitudes, and interests before and after their participation in the program. Through this evaluation, the study aims to provide insights into how community-based STEM initiatives can be optimized to serve rural communities.

Despite the global push for increased engagement in STEM (Science, Technology, Engineering, and Mathematics) education, rural schools in many countries, including Malaysia, continue to face significant challenges in providing quality STEM education. The lack of resources, qualified instructors, and access to modern STEM tools and technologies often results in lower participation rates and reduced interest in STEM fields among students in these areas. Schools in rural regions like Sabah, Malaysia, experience these challenges, further exacerbating the disparity in educational opportunities between urban and rural students [4].

Moreover, students in these rural areas may not have sufficient exposure to real-world applications of STEM concepts, limiting their understanding of how science and technology can solve everyday problems. As a result, many students in these communities lack the motivation to pursue STEM careers, which further contributes to the STEM talent shortage in the country [5]. This issue is critical as STEM disciplines are essential to fostering innovation, economic development, and technological advancement, all of which are crucial for Malaysia's competitive edge in the global economy [2]. Given these challenges, there is an urgent need for targeted interventions that can effectively engage students in STEM education, particularly in rural areas. The S.M.A.R.T. Community Program at SK Terusan Tengah in Semporna aims to bridge this gap by providing an interactive, action-oriented approach to STEM learning. However, the effectiveness of such community-based programs in promoting STEM interest among students remains under-explored, especially in rural settings like

Semporna. Therefore, this study seeks to evaluate the impact of the S.M.A.R.T. Community Program in fostering greater interest in STEM subjects among students at SK Terusan Tengah and local communities, with a focus on changes in participants' knowledge, attitudes, and interest before and after their participation in the program. The main objective of this study is to assess the impact of the S.M.A.R.T. Community Program on participants' knowledge, attitude, and interest in STEM concepts and to explore the relationships between knowledge, attitude, and interest in STEM.

The need for effective STEM education has never been more critical in preparing future generations for the challenges of an increasingly technological world. While STEM fields offer vast opportunities for innovation and economic growth, rural and underserved communities often face significant barriers to access, exposure, and engagement in these disciplines. This disparity is especially evident in regions like Semporna, where students may lack the resources, infrastructure, and support systems typically available in more urbanized areas.

The S.M.A.R.T. STEM Community Program plays a crucial role in empowering local communities by enhancing their understanding and engagement with Science, Technology, Engineering, and Mathematics (STEM). By involving students and community members from SK Terusan Tengah and the surrounding areas in hands-on STEM activities, the program fosters a deeper connection to the applications of STEM in everyday life and local development. The study highlights the importance of community-based STEM education, showing how it not only enriches participants' knowledge and attitudes but also cultivates a sustainable interest in STEM fields, which is essential for addressing local challenges.

The program's focus on community engagement ensures that STEM education is accessible and relevant to people from all backgrounds, ultimately contributing to the development of a more skilled and innovative workforce in the local community. This study underscores the long-term benefits of STEM education in driving socio-economic progress, particularly in underrepresented regions, by equipping individuals with the skills needed to solve real-world problems and participate in the global knowledge economy.

This study is significant as it explores the effectiveness of the S.M.A.R.T. Community Program in transforming communities' interests, knowledge, and attitudes towards STEM. The findings of this research will provide valuable insights into the role of community-based STEM programs in promoting education equity, particularly in rural settings. Understanding how such programs impact student engagement with STEM can inform future educational policies and help shape initiatives that can be scaled to benefit more communities. Ultimately, the study aims to contribute to the ongoing efforts to make STEM education more inclusive, accessible, and engaging for all students, regardless of their geographical location.

Materials and methods

1. Study Design

This research utilized a pre-test/post-test design to measure changes in participants' STEM knowledge, attitudes, and interests before and after their participation in the program. The participants included students from SK Terusan Tengah, students from SMK Bum-Bum, and members of the local community. A survey questionnaire with Likert-scale items was distributed to the participants to gather quantitative insights into participants' perceptions of the program and its impact on their STEM learning experience. The survey questionnaire questions were adopted from Mastura & Azri [6].

2. Sampling and Participants Program Activities

The study involved approximately 500 participants, including 247 students from SK Terusan Tengah (primary school), 103 students from SMK Bum-Bum (secondary school), and 150 community members from Pulau Bum-Bum. These participants were selected using purposive sampling, as they were the direct beneficiaries of the S.M.A.R.T. Community Program. The study focused on both students and the local community to assess the broader impact of the program on STEM education in the region.

3. Program Activities

The S.M.A.R.T. STEM Community Program at SK Terusan Tengah was designed to engage participants in a series of interactive and educational activities aimed at enhancing their understanding and interest in STEM fields. The program included hands-on workshops focusing on key STEM concepts such as robotics, programming, and the Internet of Things (IoT). Participants actively engaged in group activities where they applied theoretical knowledge to real-world scenarios, fostering critical thinking and problem-solving skills. Additionally, the program incorporated practical demonstrations and interactive sessions to highlight the relevance of STEM in everyday life and local community development. Through these activities, the program not only sought to enhance participants' technical knowledge but also aimed to cultivate a positive attitude towards STEM disciplines, encouraging future participation in STEM-related education and careers.

4. Data Collection Methods

A pre-program survey was conducted to assess participants' initial knowledge, attitudes, and interest in STEM. A post-program survey was then administered to evaluate any changes in these areas following the completion of the program. The survey employed a Likert scale to quantify responses, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

5. Data Analysis

The research employed a pre-test/post-test design to evaluate the effectiveness of the S.M.A.R.T. STEM Community Program in enhancing participants' knowledge, attitudes, and interests in STEM. Participants (n=500) included students from SK Terusan Tengah, SMK Bum-Bum, and members of the local community. A survey questionnaire with Likert-scale items was administered to the participants before and after the program to assess changes in their STEM-related knowledge, attitudes, and interests. The collected data were analysed using descriptive statistics to summarize the participants' responses, and correlation analysis was applied to examine the relationships between the program's impact on knowledge, attitude, and interest in STEM. Pearson's correlation coefficients were calculated. This quantitative approach allowed for a comprehensive analysis of the measurable outcomes and the impact of the program on participants' STEM learning experiences.

Results and Discussion

The findings from the S.M.A.R.T. STEM Community Program indicate that the program significantly enhanced participants' knowledge, attitudes, and interest in STEM fields. The high mean scores in all three areas (Knowledge = 4.50, Attitude = 4.64, Interest = 4.52) suggest that the program was effective in increasing participants' understanding of STEM concepts, fostering a positive attitude towards STEM, and cultivating greater interest in pursuing STEM-related careers and activities. In terms of knowledge, participants demonstrated a solid grasp of STEM concepts, including the relationship between science, technology, engineering, and mathematics, as well as the real-world applications of STEM in fields like robotics, programming, and agriculture (Table 1). This aligns with the findings of previous studies that emphasize the importance of hands-on, experiential learning in increasing students' knowledge and understanding of STEM [7].

Table 1: The descriptive analysis of participants' knowledge in STEM

Item	Mean	Standard Deviation
STEM is related to Science, Technology, Engineering, and Mathematics.	4.50	0.62
I understand the concept of STEM.	3.90	0.96
STEM is important in life and learning.	4.30	0.66
I have never been exposed to the concept of STEM.	3.20	1.21
Robotics, programming, and IoT use STEM concepts.	4.20	0.72
STEM concepts should be implemented and applied.	4.40	0.68
STEM education produces graduates with scientific and technological skills.	4.50	0.64
STEM can solve problems.	4.20	0.64
STEM fosters an innovative society.	4.20	0.89
Agrotechnology and aquaculture are part of STEM.	4.20	0.73

Regarding attitudes, the program successfully fostered a positive attitude towards STEM, with participants expressing excitement and enthusiasm about engaging in STEM-related activities (Table 2). This is consistent with the work of Lee and co-authors [8], who found that exposure to interactive STEM activities can significantly improve students' perceptions and attitudes towards STEM subjects.

Table 2: The descriptive analysis of participants' attitude in STEM

Item	Mean	Standard Deviation
I enjoyed participating in this program.	4.64	0.52
I am skilled in performing STEM group activities in this program.	4.33	0.76
This program helped me understand STEM concepts.	4.44	0.74
I mastered each STEM-related activity in this program.	4.27	0.8
I am interested in attending more STEM-related classes.	4.32	0.77
It is important to know STEM to secure a good job.	4.46	0.72
I want to have a job related to STEM.	4.39	0.82
Having a job related to STEM will help me succeed in life.	4.47	0.72
STEM makes our lives better.	4.38	0.71
The benefits of STEM knowledge outweigh any possible harmful effects.	4.27	0.81
STEM is good for the future of our country.	4.47	0.66
When something new is discovered, I want to learn about it quickly.	4.45	0.65
STEM plays an important role in life.	4.50	0.69

As for interest, the program demonstrated its success in piquing participants' curiosity and motivation to learn more about STEM (Table 3). The high levels of interest reported by participants are in line with findings by Hosseini and co-authors [9], who concluded that well-structured STEM programs not only increase knowledge but also ignite a lasting interest in STEM careers. When comparing the S.M.A.R.T. STEM Community Program's findings to other similar studies, it is evident that hands-on, community-based STEM programs consistently yield positive outcomes. For example, the STEM Camp organized by the Malaysian Ministry of Science, Technology, and Innovation (MOSTI) in 2016 showed a significant improvement in participants' STEM knowledge and attitudes after just a few days of engagement [10]. Similar results were found in the United States, where community outreach programs like the STEM Education Initiative showed improved attitudes and greater interest in pursuing STEM careers among middle and high school students [11]. However, what sets the S.M.A.R.T. STEM Community Program apart is its focus not only on knowledge and attitudes but also on community engagement, which enhances the program's impact. By involving students from local schools and community members, the program fosters a broader, more inclusive approach to STEM education, which aligns with the work of Brown and Green [12], who argue that community-based STEM education creates opportunities for more diverse participation and higher long-term impact.

Table 3: The descriptive analysis of participants' interest in STEM

Item	Mean	Standard Deviation
I enjoy participating in STEM-related activities.	4.39	0.08
I would feel regretful if I missed STEM-related activities.	4.30	0.09
I find STEM-related activities beneficial.	4.43	0.07
I complete STEM-related activities on time and with accuracy.	4.32	0.08

I strive to understand STEM concepts.	4.43	0.07
I ask the facilitator when I am unclear about STEM-related topics.	4.32	0.07
I discuss STEM-related activities with my friends.	4.38	0.07
I try to find additional materials about STEM activities from libraries or the internet.	4.52	0.06

In terms of the relationship between knowledge, attitude, and interest, there is a strong positive correlation (0.81), indicating that as participants' knowledge about STEM increases, their attitude towards STEM also becomes more positive. The correlation between knowledge and interest is also strong (0.75), suggesting that increased knowledge about STEM leads to greater interest in engaging with STEM-related activities. A very strong positive correlation (0.88) was observed between attitude and interest. This indicates that as participants' attitudes towards STEM become more positive, their interest in pursuing STEM subjects increases as well.
Overall, the results suggest that enhancing participants' knowledge about STEM, improving their attitudes, and fostering their interest in STEM are all interrelated and mutually reinforcing.

Conclusion

S.M.A.R.T. STEM Community Program indicates that the program successfully enhanced participants' knowledge, attitudes, and interest in STEM fields. The descriptive analysis revealed high mean scores across all three areas, with Knowledge scoring a mean of 4.50, Attitude at 4.64, and Interest at 4.52. These scores suggest that the program had a significant positive impact on participants, significantly increasing their understanding of STEM concepts, fostering positive attitudes towards STEM, and cultivating greater interest in pursuing STEM-related careers and activities. Further analysis using correlation analysis showed that there were strong positive relationships between the three variables. These results underscore the interdependent nature of knowledge, attitude, and interest in STEM. They highlight that enhancing one of these factors, such as knowledge, not only boosts participants' attitudes but also sparks their interest in further STEM exploration. The program's success demonstrates the importance of hands-on activities and community engagement in fostering STEM skills and enthusiasm, and it emphasizes the need for programs that integrate these aspects to achieve long-term impact in STEM education.

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