STEM Edutourism Exploring Impacts on Knowledge, Attitudes, and Motivation via the Malaysia-Singapore Science Field Trip

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Abstract
This study investigates the impact of a four-day Malaysia-Singapore science field trip on enhancing STEM engagement among educators, students, and stakeholders. Using a mixed-methods approach, data was collected via structured surveys with quantitative Likert-scale items and qualitative open-ended questions. Quantitative data was analyzed with SPSS, while qualitative themes were extracted using a word cloud tool. The findings reveal significant positive outcomes in three areas: STEM knowledge, attitudes, and motivation. Participants reported enhanced understanding of advanced technologies, innovative teaching methods, and real-world STEM applications. They also expressed greater interest in STEM, a willingness to explore new areas, and recognition of STEM's importance in shaping the future. The trip also increased participants' motivation to apply their knowledge, engage in STEM activities, and inspire others. A key element of the trip was the comparative exposure to Malaysia's potential for STEM growth and Singapore's advanced technological infrastructure. This cross-border perspective encouraged participants to reflect on diverse approaches to STEM development and their roles in advancing it. Overall, STEM edutourism, through immersive and comparative experiences, proved effective in enhancing engagement with STEM. By integrating hands-on learning and exposure to real-world applications, such initiatives inspire motivation and a commitment to STEM innovation.

Keywords: Edutourism, Science Trip, Field Trip, STEM Engagement, STEM Attitudes, STEM Motivation.

Introduction

STEM (Science, Technology, Engineering, and Mathematics) education is crucial for cultivating innovation and addressing global challenges. While STEM outreach to schools has shown promise in sparking initial interest in STEM fields (Azman et al., 2019; Hassan et al*.,* 2021, Moid et al., 2021), traditional classroom instruction often falls short in sustaining genuine engagement. This has led to a growing interest in alternative learning methods, such as edutourism. By combining educational

experiences with travel, edutourism offers a more immersive and engaging approach, potentially delivering greater impact on learning outcomes and fostering a deeper connection to STEM.

Experiential learning through field trips increases student interest, knowledge, and motivation (Ramachandiran & Dhanapal, 2016). Field trips build students' knowledge and improve their attitudes and intentions. In fact, field trips can lead to knowledge gains exceeding the results expected from traditional learning theories (Putz et al., 2018).

STEM edutourism offers distinct chances for participants to interact with STEM concepts in immersive, hands-on settings. The Malaysia-Singapore Science Field Trip serves as an excellent case study. Singapore is an ideal location to study STEM education because it has more advanced infrastructure and a higher adoption rate of emerging technologies supported by strong government initiatives. Singapore also often leads in fostering public-private partnerships and creating ecosystems for startups. The Singapore government emphasizes the importance of STEM education in sustaining their economic growth, focusing on cultivating STEM experts, proficient workers, and STEM-literate citizens (Teo & Choy, 2021).

The Malaysia-Singapore Science Field Trip also includes visits to Malaysia, in order to give participants a basis for comparison and self-reflection. This type of comparison allows for a more nuanced understanding of STEM education and its applications. By studying the approaches and outcomes of two distinct but interconnected nations, participants can gain a deeper understanding of STEM's global implications and the factors that shape its success in different contexts.

Despite the increasing popularity of STEM-focused Edu tourism, limited research exists on its impact, particularly in cross-border contexts like Malaysia and Singapore. This study seeks to address this gap by evaluating how the Malaysia-Singapore Science Field Trip influences participants' STEM knowledge acquisition, attitudes toward STEM, and motivation to pursue STEM-related pathways. By understanding these outcomes, the research will be able to highlight the role of STEM edutourism in fostering meaningful engagement and informing the design of future educational initiatives that bridge academic learning with experiential exploration.

Methodology

Data Sampling

The study involved a purposive sample of 30 Malaysian participants, comprising educators (11 participants), students (8 participants), and external stakeholders (11 participants) as illustrated in Figure 1a. The educators included school teachers and university lecturers, while the students were a mix of school and university attendees. The external stakeholders consisted of decision-makers from government education agencies, STEM engagement professionals, and librarians, providing varied perspectives on STEM edutourism. The sample was predominantly female, with 22 female participants and 8 male participants as illustrated in Figure 1b.

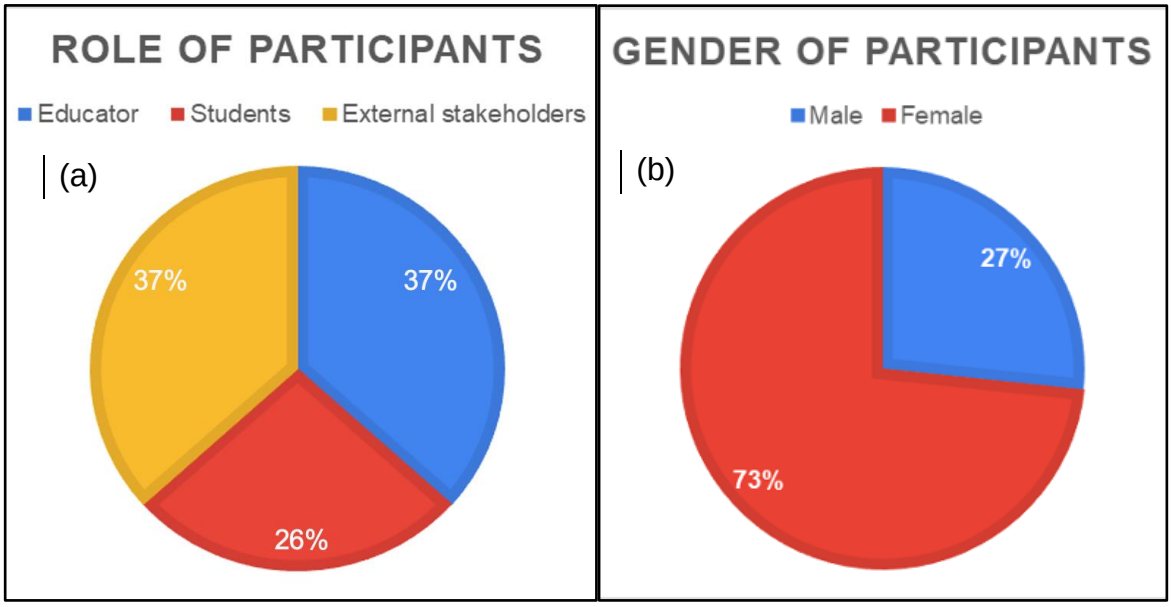

Figure 1: Demographic Information of Participants, Including (A) Their Roles and (B) Their Gender Distribution.

Field Trip Design

The Malaysia-Singapore Science Field Trip, organized by the National STEM Association, Malaysia, was conducted over four days, from November 4 to November 7, 2024. The program was designed to provide participants with a dynamic combination of cultural exploration, STEM-focused activities, and informal learning opportunities across two countries.

Day 0 (November 4, 2024):
Participants departed by bus from Kuala Lumpur to Johor, Malaysia. This travel day allowed the group to prepare for the upcoming activities.

Day 1 (November 5, 2024):
The first day in Singapore featured iconic landmarks and cultural experiences, starting with a visit to Merlion Park. This was followed by self-exploration at Kampong Gelam, a site rich in heritage and cultural significance. Participants also explored the innovative Jewel Changi Airport, renowned for its architectural and technological features. The day concluded with the Spectra Light and Water Show at Marina Bay Sands. During the bus journeys, a tour guide provided insightful commentary about the sites and their significance.

Day 2 (November 6, 2024):
The second day was dedicated to STEM-centered activities, beginning with a formal visit to EduTech Asia 2024, an international platform showcasing advancements in educational technology. This was followed by an engaging trip to the Singapore Science Centre, where participants interacted with hands-on STEM exhibits. The day ended with a visit to the scenic Gardens by the Bay, blending nature and technological innovation.

Day 3 (November 7, 2024):
The final day brought the group back to Johor, Malaysia. Activities began with a visit to Idrissi International School's Johor Bahru branch, located in Educity, Iskandar

Puteri, where participants explored its innovative learning environment and curriculum. This was followed by a trip to Stadium Sultan Ibrahim, where participants marveled at its modern, world-class architectural design. The trip concluded with a guided tour of Legoland Malaysia Resort, blending recreational fun with engineering and creative insights.

This carefully curated itinerary, organized by the National STEM Association, Malaysia, provided participants with a holistic experience, integrating cultural appreciation and STEM engagement to inspire learning and exploration.

Data Collection

This study employed a mixed-mode method to collect both quantitative and qualitative data, ensuring a comprehensive evaluation of the Malaysia-Singapore Science Field Trip impact on participants' STEM knowledge, attitudes, and motivation. Data was gathered through a structured survey administered at the end of the trip, divided into five sections: Section 1 collected demographic information (role, gender, and institutional affiliation), Section 2 assessed the Knowledge domain, Section 3 evaluated the Attitude domain, Section 4 focused on the Motivation domain, and Section 5 provided space for participants to offer feedback and comments.

The quantitative component of the survey included closed-ended questions utilizing a 5-point Likert scale to measure participants' perceptions of STEM knowledge gained, their attitude toward STEM education, and their motivation for engaging in STEM activities. The qualitative component comprised open-ended questions, allowing participants to share specific knowledge they gained, elements of the trip that influenced their attitudes, and any intended behavioral changes resulting from the experience.

The survey used in this study was a modified version of instruments from previous studies, tailored to assess the unique impact of STEM edutourism (Morgan et al., 2022; Paul, 2020; Putz et al., 2018). By combining numerical data with detailed personal reflections, the mixed-mode approach provided a multidimensional understanding of the STEM edutourism experience. To ensure candid responses, all survey data were anonymized. This comprehensive design enabled a robust evaluation of the field trip’s outcomes and areas for improvement.

Data Analysis

The data collected from the survey was analyzed using the Statistical Package for the Social Sciences (SPSS) software and a word cloud tool from Simple Word Cloud. A quantitative research method, specifically descriptive statistics, was used to measure the central tendency (mean) and variation (standard deviation) for the 5-point Likert scale questions. This provided insights into overall trends and variations in participants' perceptions of STEM knowledge, attitudes, and motivation.

For the qualitative data from the open-ended questions, a word frequency analysis was performed using the Simple Word Cloud tool (available at https://www.simplewordcloud.com). This allowed for the identification of frequently used terms, providing a visual representation of key themes and insights in participants' responses. By combining both the SPSS statistical analysis and the word

cloud results, the study gained a comprehensive understanding of the impact of the Malaysia-Singapore Science Field Trip on STEM engagement.

Results and Discussion

This study investigates the effectiveness of a four-day Malaysia-Singapore science field trip aimed at enhancing participants' STEM engagement, particularly in the domains of knowledge, attitudes, and motivation. The main findings are presented in tables and graphs, organized by their respective domains.

STEM Knowledge

Based on Table 2 and Figure 2, this study offer valuable insights into the types of knowledge gained by participants during this trip. These visual representations, a frequency table and a word cloud, complement the quantitative survey data by providing a qualitative glimpse into the participants' learning experiences.

Table 2: Frequency Table of The Top 10 Most Common Terms Mentioned for Knowledge Gained from The Field Trip

Word	Frequency
STEM	25
Learning	24
Technology	10
Science	9
AI	8
Education	7
Teaching	6
Innovation	6
Robotics	3
School	3

The most frequent term was "STEM" (25 occurrences), suggesting that participants gained a more comprehensive understanding of STEM fields and their interconnectedness. "Learning" was mentioned 24 times, indicating that participants likely gained new insights into effective teaching and learning approaches, particularly in STEM education. "Technology" appeared 10 times, highlighting the trip's focus on exposing participants to advanced technologies and their applications in various sectors, such as education, urban planning, and environmental sustainability. Other frequently mentioned terms include "Science," "Education," and "Teaching," further reinforcing the trip's emphasis on STEM learning.

Past review paper summarizes key findings from research on field trips over three decades and emphasizes that field trips can lead to better learning outcomes compared to traditional classroom instruction under favorable circumstances (DeWitt & Storksdieck, 2008). A different study explores the benefits of field-based learning across a range of courses, including natural sciences, social sciences, and

humanities. This particular study argue that field-based learning facilitates learning in ways that cannot be replicated in traditional classrooms (Fedesco et al., 2020).

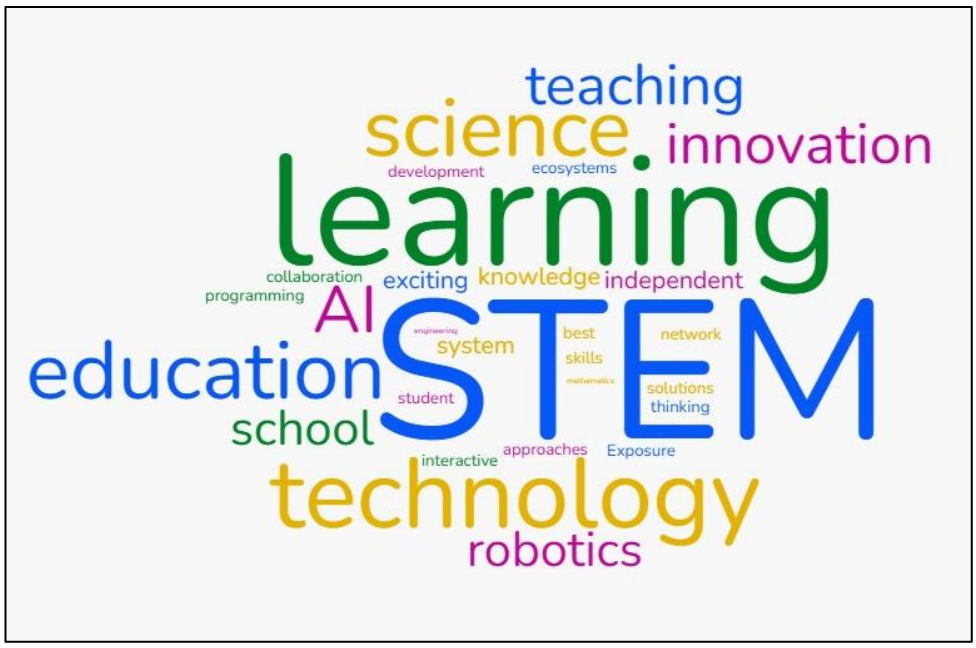

Figure 2: Word Cloud Depicting New Knowledge Gained from The Field Trip

Figure 2, a word cloud, provides a more comprehensive view of the knowledge gained. The size of the words in the cloud reflects their frequency in participants' responses. While "STEM" and "Learning" dominate, as in Table 2, the cloud highlights additional themes that are not included in the table. The prominent presence of terms related to advanced technologies such as “AI” and “robotics” in Figure 2 suggests that the field trip is able to expose participants to cutting-edge developments in STEM fields.

The inclusion of "AI" (Artificial Intelligence) indicates that participants likely encountered AI applications in various contexts, possibly in educational technology exhibits at EduTech Asia or interactive displays at the Singapore Science Centre. This exposure aligns with the growing emphasis on AI in STEM education, as highlighted in various sources. For example, the ITE in Singapore incorporates "AI machine learning" into their technology-based programs (Rezaie et al., 2022). Another study highlights AI-based tutoring as an emerging educational technology tool (Turman, 2024).

The prominence of terms like "interactive," "exciting," and "independent" in Figure 2 speaks to the field trip's success in providing participants with a highly engaging learning experience. The term "interactive" suggests that participants were actively engaged in hands-on activities, experiments, and demonstrations, rather than passively receiving information. The term "exciting" indicates that participants found the field trip stimulating and enjoyable, suggesting that the learning experiences were designed to capture and maintain their interest. The inclusion of "independent" implies that participants had opportunities for self-directed learning and exploration, allowing them to pursue their interests and develop a sense of ownership over their learning.

These findings align with the concept of Edu tourism, which emphasizes the importance of engaging, hands-on learning experiences that combine education with travel. Several studies have highlighted that experiential learning, especially when it is enjoyable and stimulating, enhances knowledge retention and motivates participants to explore new concepts. The emphasis on interactive, exciting, and independent learning experiences during the field trip supports the idea that Edu tourism can foster both personal growth and educational development. By integrating fun, exploration, and self-directed learning, the trip mirrors key principles from literature on Edu tourism that underscores the value of making learning enjoyable and engaging to maximize its impact (Fitria, 2024; Kamdi et al., 2016).

Table 3: Descriptive Measures of Respondents' Perceptions of Knowledge Acquired

Items	Mean	Standard deviation
P1: Inspire Curiosity	4.60	0.621
P2: Disseminate STEM Knowledge	4.40	0.621
P3: Disseminate STEM Skills	4.27	0.640
P4: Raise STEM Awareness	4.63	0.615
P5: Motivate Peers in STEM Education	4.73	0.583

Table 3 presents the mean scores and standard deviations for five items related to STEM knowledge acquisition, which are further illustrated in the bar chart in Figure 3. The highest mean score, 4.73, was recorded for the item measuring participants' motivation to inspire their peers in STEM education, indicating a very strong motivational impact. Other items, such as "Inspire Curiosity" (4.60) and "Raise STEM Awareness" (4.63), also received high ratings, with low standard deviations, suggesting the field trip effectively sparked curiosity and increased awareness of STEM fields. Participants also rated the trip highly for disseminating STEM knowledge (4.40) and STEM skills development (4.27), indicating the field trip's success in broadening participants' understanding and enhancing their STEM capabilities.

Past findings support the idea that field trips can foster curiosity (Powell et al*.,* 2022) and raise awareness of science-related concepts and careers (Ramachandiran & Dhanapal, 2016). This study indicated positive student perceptions of the impact of field trips on their understanding of the subject. One study found that field trips effectively built students' knowledge, improved their attitudes, and increased their intentions to use sustainable transport modes. While the study focuses on sustainable transport, it highlights the broader potential of field trips to raise awareness of STEM-related issues and their real-world applications (Putz et al*.,* 2018).

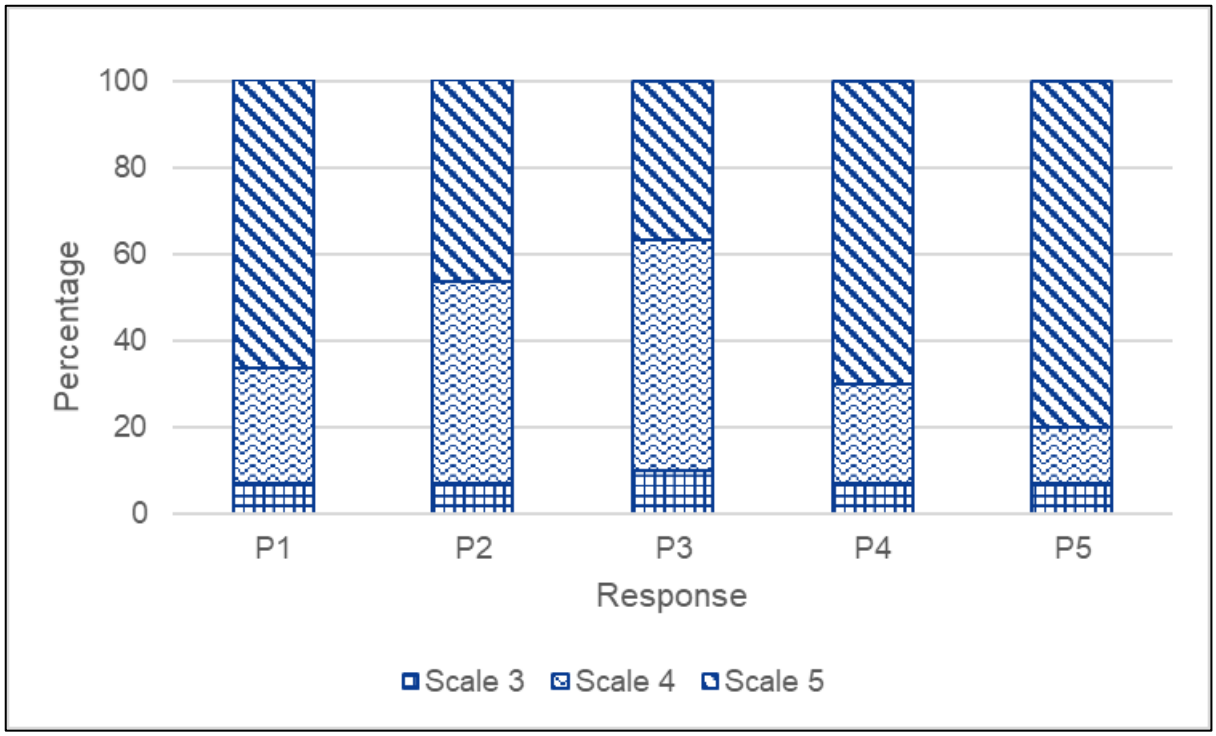

Figure 3: Percentage of Respondents' Perception of Knowledge Acquired During The Trip Based on A 5-Point Likert Scale

Figure 3 further supports these findings by visually representing the percentage of respondents who agreed with each statement. Over 80% of participants agreed or strongly agreed with all items, with the highest agreement on the motivational impact ("This trip has motivated me to encourage my peers in STEM education"), where over 90% of respondents expressed strong agreement. The combined analysis of Table 3 and Figure 3 highlights the trip's success in increasing STEM knowledge, inspiring curiosity, raising awareness of STEM's importance, and motivating participants to engage in STEM and promote it to others. The high scores and agreement percentages across all areas affirm the field trip's effectiveness in achieving its goals.

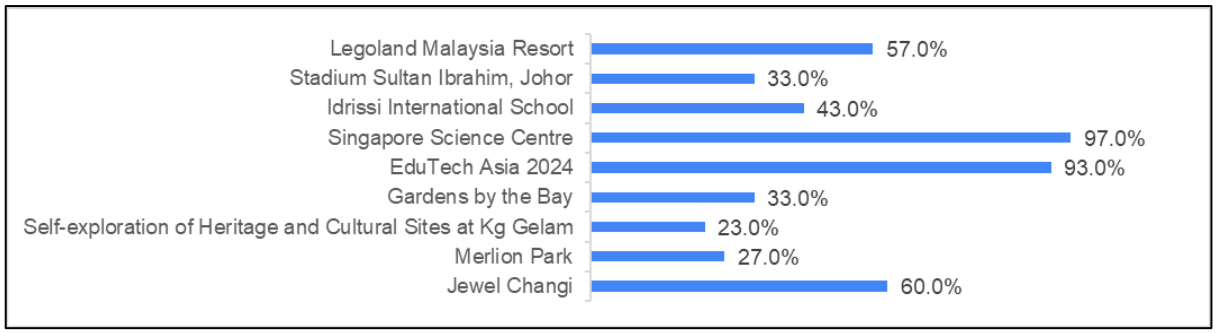

Figure 4: Respondents' Perceptions of Trip Elements Contributing to Knowledge Acquisition

Figure 4 visually represents participant perceptions of which specific elements of the trip contributed most to their knowledge acquisition. Visiting the Singapore Science Centre emerges as the most impactful element (97%), receiving the highest

rating from participants. This finding highlights the effectiveness of interactive exhibits and hands-on experiences in facilitating STEM learning. Participants likely benefited from engaging with scientific principles in a dynamic and engaging environment. Several studies strongly indicate the Science Centre's significance in promoting STEM education. Its hands-on exhibits, immersive environment, and outreach initiatives contribute to its effectiveness in engaging students with STEM concepts, making it a valuable asset in Singapore's efforts to cultivate a strong STEM workforce for the future (Subramaniam & Hoh, 2021; Teo & Choy, 2021).

The EduTech Asia 2024 exhibition ranks as the second most influential element (93%). This suggests that exposure to cutting-edge educational technologies and innovations played a significant role in enhancing their understanding of STEM concepts and applications. While less prominent than the top two, other elements also received positive ratings. Though Legoland is primarily a recreational destination, it also offers opportunities to explore engineering concepts, creativity, and problem-solving skills, potentially contributing to participants' STEM knowledge in an informal and enjoyable setting.

STEM Attitude

Table 5 presents the descriptive statistics for respondents' attitudes toward this trip, with four attitude statements (A1–A4) assessed on a 5-point Likert scale. The mean scores for all items range from 4.57 to 4.77, reflecting a strong agreement among participants regarding their positive attitudes toward the trip. The low standard deviations, ranging from 0.430 to 0.679, suggest that the participants' responses were highly consistent, indicating widespread approval of the field trip's impact on their views about STEM. These results underscore the trip's effectiveness in fostering a positive attitude toward STEM engagement and exploration.

Table 5: Descriptive Measures of Respondents' Attitudes Towards The Trip

Items	Mean	Standard deviation
A1: I learned more about a specific aspect of STEM or gained more STEM content knowledge.	4.60	0.621
A2: I realized that science involves more components or aspects than I previously thought.	4.57	0.679
A3: I feel more willing to try new things or explore new STEM areas.	4.77	0.430
A4: This experience made me more interested in STEM, either generally or in a specific context.	4.70	0.496

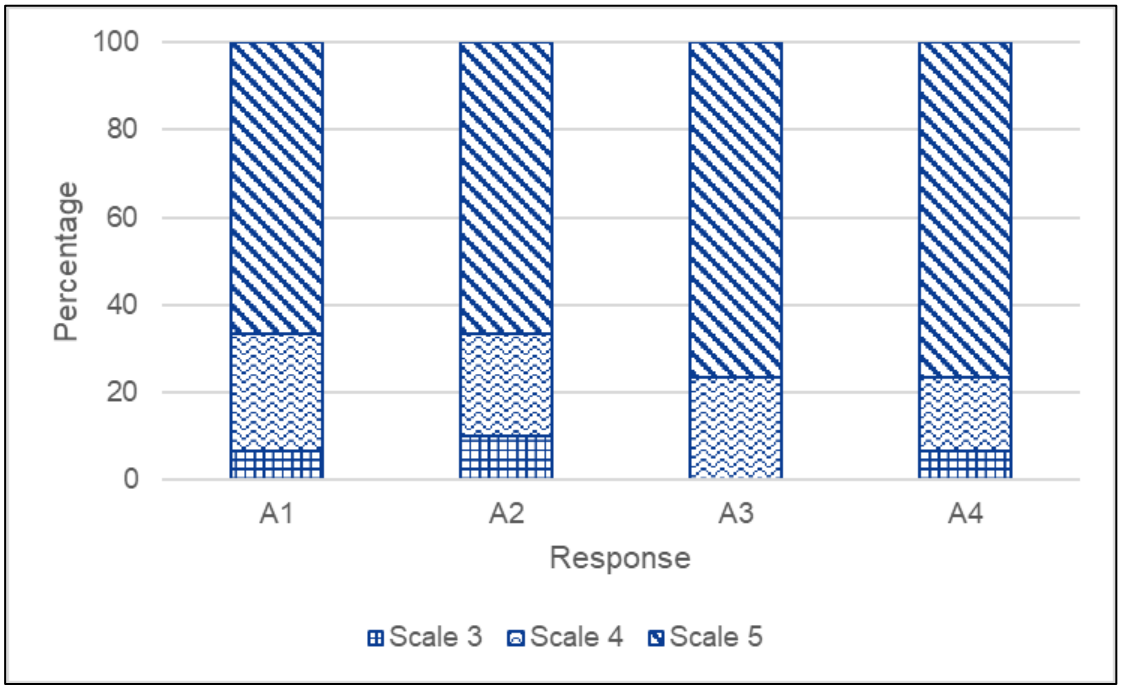

Figure 5: Percentage of Respondents' Agreement with Attitude Statements Based on A 5-Point Likert Scale

Figure 5 complements Table 5 by visually presenting the percentage of respondents who agreed with each attitude statement. Majority of respondents "Strongly Agreed" or "Agreed" with statements A3 ("I feel more willing to try new things or explore new STEM areas") and A4 ("This experience made me more interested in STEM, either generally or in a specific context"), highlighting the trip's success in increasing participants' willingness to engage with new STEM areas and deepening their interest in the field. The alignment between the descriptive statistics and visual representation in Figure 5 emphasizes the strong positive impact of edutourism, reinforcing findings from previous studies that field trips can significantly enhance students' attitudes and interest in STEM subjects (Behrendt & Franklin, 2014; Campbell & Gedat, 2021).

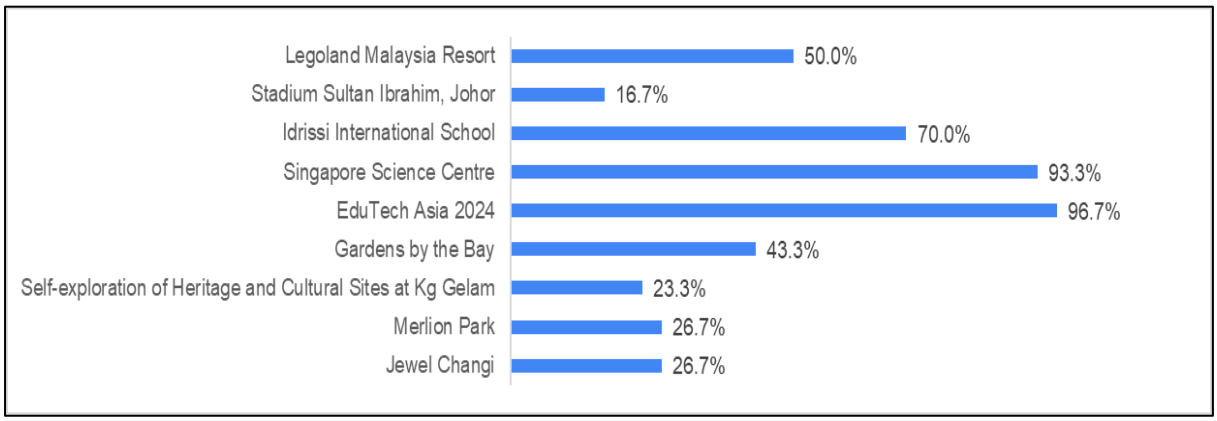

Figure 6: Trip Elements That Potentially Influenced Attitudes Towards Stem

Figure 6 illustrates the elements of the Malaysia-Singapore Science Field Trip that had the greatest influence on participants' attitudes toward STEM. The results highlight the significance of various trip components, with the highest percentages reflecting the most impactful elements. Notably, the visit to EduTech Asia 2024 (96.7%) and the Singapore Science Centre (93.3%) were identified as the most influential in shaping participants' attitudes. Interactions with STEM professionals at these institutions likely provided participants with valuable insights into real-world applications of STEM, boosting their perception of the field. Such direct exposure to STEM experts can play a key role in inspiring participants to pursue STEM careers or deepen their interest in STEM subjects.

Exposure to advanced technology and hands-on activities also emerged as major contributors to positive attitudes. Visits to innovative spaces like Gardens by the Bay and Jewel Changi Airport, as well as engaging in interactive exhibits at the Singapore Science Centre, helped participants connect theoretical STEM knowledge to practical, real-world applications. The observation of cutting-edge technology in action, alongside interactive learning opportunities, likely sparked curiosity and excitement about the potential of STEM to shape the future. Furthermore, the chance to compare the STEM landscapes of Malaysia and Singapore, though slightly less influential, broadened participants' perspectives on global STEM trends, fostering a greater appreciation for diverse approaches within the field.

Even though the impact of a positive attitude is not exclusive to the Edutourism (Azman *et al.,* 2021; Habeeb, 2024), these findings align with Figure 4, which indicates that the same elements that contributed to knowledge acquisition also had a significant role in shaping participants' attitudes toward STEM. This suggests that the experiential nature of the trip, through interactions, exposure to technology, and hands-on learning, was instrumental in cultivating a positive attitude toward STEM engagement.

STEM Motivation

The findings in Table 7 and Figure 7 suggest that the Malaysia-Singapore Science Field Trip had a positive influence on participants' motivation towards STEM. The high mean scores for the motivation items, ranging from 4.50 to 4.73, indicate that participants reported feeling more motivated to engage with STEM activities and studies following the trip. Notably, a large majority of respondents (over 90%) expressed a heightened motivation to encourage others to pursue STEM, suggesting that the trip may have inspired a sense of advocacy for STEM within their social circles.

Table 7: Descriptive measures of respondents' motivation after the trip

Items	Mean	Standard deviation
M1: I intend to use what I learned on this trip in the near future.	4.50	0.572
M2: I feel more motivated to engage in STEM-related activities or studies as a result of this experience.	4.63	0.669
M3: I am more likely to encourage others to participate in STEM activities or pursue STEM education.	4.73	0.521

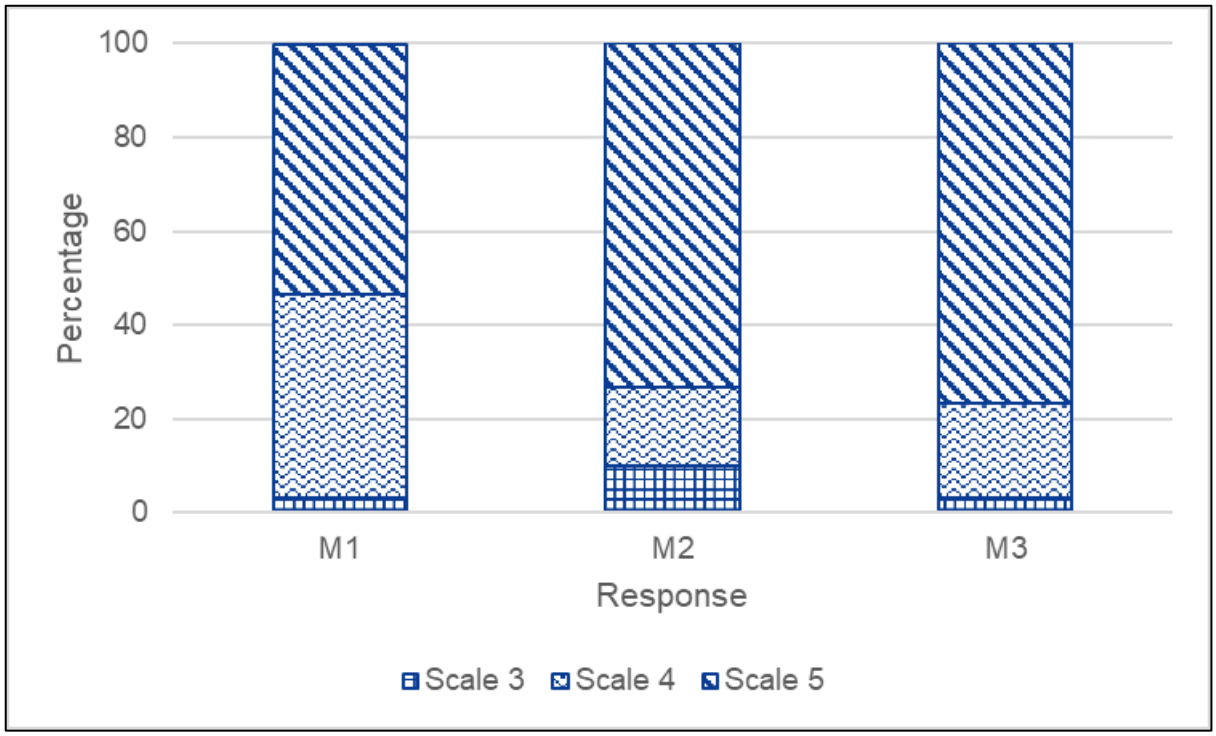

Figure 7: Percentage of Respondents' Agreement with Motivation Statements Based on A 5-Point Likert Scale

Figure 7 further highlights that many participants felt more inclined to apply what they had learned, with approximately 90% agreeing that they were motivated to engage in STEM-related activities, and around 98% expressing an intention to use their newly acquired knowledge in the near future. These findings align with existing literatures on the potential of field trips to stimulate interest and engagement in STEM (Duc & Ha, 2022; Fedesco *et al.,* 2020; Rahman *et al.,* 2023), although further studies would be needed to assess the long-term impact and broader effects of such experiences.

Table 8: Frequency Table of The Top 10 Most Common Terms Mentioned in Respondents' Comparisons of Technology and Innovation Between Malaysia and Singapore

Word	Frequency
Technology	32
Innovation	12
Advanced	9
Potential	4
Strong	4
Digital	3
Infrastructure	3
Economy	3
Smart	3
Resources	2

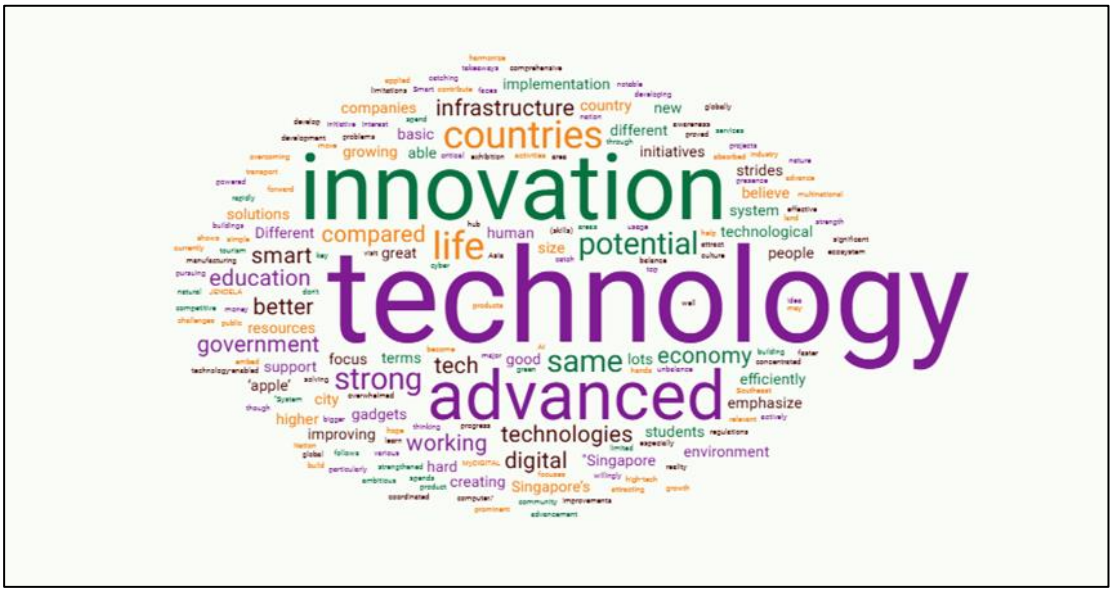

Figure 8: Word Cloud Depicting Comparisons of Technology and Innovation Between Malaysia and Singapore

The analysis of Table 8 and Figure 8 sheds light on participants' comparative perceptions of the technological landscapes in Malaysia and Singapore, shaped by their experiences during the visit. Table 8 provides a quantitative breakdown of word frequencies in participants' responses, while Figure 8, through a word cloud, visually emphasizes the most frequently mentioned terms. The prominence of "Technology" (32 mentions) and "Innovation" (12 mentions) highlights the centrality of these concepts in participants' reflections, suggesting the trip effectively exposed them to advanced technological applications and progressive innovation strategies. Words like "Advanced" (9 mentions) and "Potential" (4 mentions) reflect participants' nuanced views, acknowledging Singapore's established technological edge and Malaysia's opportunities for future growth.

This comparative understanding likely enhanced participants' STEM motivation. Experiencing cutting-edge environments, such as Singapore's smart nation initiatives and technological landmarks like Jewel Changi Airport, provided tangible examples of how STEM drives societal progress. Such exposure not only sparked curiosity but also demonstrated the practical relevance of STEM in shaping economies and infrastructures. Observing Malaysia's potential for growth may have inspired participants to envision themselves as contributors to national development through STEM. The positive association between these experiences and their reflections underscores the role of such field trips in fostering a deeper engagement with STEM and motivating participants to pursue STEM pathways while encouraging others to do the same.

Nevertheless, it is crucial to remember that these findings represent the perceptions of the field trip participants, shaped by their specific experiences and the focus of the program. While providing valuable insights, these perceptions should not be interpreted as definitive assessments of the overall technological landscapes of Malaysia or Singapore.

Table 9: Positive Experiences and Feedback from Participants

Positive experiences, responds and elements participants particularly liked
What I enjoyed most about this trip was the chance to see and experience technology in action. At the EduTech Expo, I loved exploring new educational tools, like virtual reality, that make learning more exciting and interactive. Visiting the Singapore Science Centre was also a highlight, as I got to try hands-on experiments and see science brought to life in a way that made complex ideas easy to understand.
I am still amazed by the construction and the ideas behind using technology for country development. It truly maximizes technology while balancing the country's needs.
To witness firsthand how technology and innovation are seamlessly integrated into education was truly inspiring. I had the opportunity to speak with education program providers for schools in Singapore, and it was amazing to hear about their innovative approaches to STEM learning, the emphasis on hands-on experiences, and the strong collaboration between educators, students, and industry partners to shape the future of education.
Engaging with experts, exploring interactive exhibit and experiencing innovative tools to enhance my teaching methods.
I really enjoyed this trip. I mostly enjoyed going to Changi Jewels and I would say it does fit the title. Next, I was excited to watch the light show at Marina Bay Sands and have a fun experience in Legoland. It was phenomenal and to conclude, I enjoyed everything throughout this trip.

The feedback in Table 9 highlights participants' overwhelmingly positive experiences during the Malaysia-Singapore Science Field Trip, emphasizing elements that align with STEM motivation and the overall theme of fostering a deeper connection with science, technology, and innovation. Participants frequently referenced the opportunities to witness and engage with advanced technologies, interactive tools, and innovative educational methods. For instance, the EduTech Expo and Singapore Science Centre stood out as pivotal experiences, offering immersive, hands-on exposure to technologies like virtual reality and experiments that made complex STEM concepts accessible and exciting. Such experiences not only enhanced participants' understanding of STEM but also inspired enthusiasm for integrating these tools into their educational or professional contexts.

These reflections demonstrate how the trip bolstered STEM motivation by showcasing real-world applications of science and technology in diverse settings, from infrastructure to education. Participants expressed awe at Singapore's integration of technology into national development and its emphasis on collaborative, hands-on learning approaches. This exposure likely encouraged them to see STEM as a dynamic and impactful field, fostering a sense of purpose to contribute meaningfully in their contexts. Additionally, enjoyable cultural experiences, such as the light show at Marina Bay Sands and the visit to Legoland, reinforced the value of learning in an engaging, multifaceted environment. These experiences underscore the trip’s success in creating a lasting, motivational impact, blending STEM education with personal enrichment, and fulfilling the broader objective of connecting participants to the

transformative potential of science and technology. The recent pandemic posed significant challenges, bringing edutourism and STEM outreach programs to a halt. While previous studies have focused on developing online modules to address such disruptions (Azman *et al*., 2022; Vermeulen *et al*., 2022), further studies could examine ways to incorporate the core elements of edutourism, particularly exploration and self-directed learning, into virtual or hybrid formats.

Conclusion

This study explores the effectiveness of edutourism in enhancing STEM engagement among participants. The findings, derived from a mixed-methods approach using surveys and word cloud analysis, strongly suggest that STEM edutourism holds significant potential for fostering meaningful STEM engagement.

The comparative element of the trip, contrasting the STEM landscapes of Malaysia and Singapore, also contributed to participants' motivation. The word frequency analysis as illustrated in Table 8 highlights their perceptions of Singapore as technologically "advanced" while recognizing Malaysia's "potential" for growth. This suggests that the trip fostered critical thinking about the various approaches to technological development and the role of STEM in shaping economies and societies.

Overall, the study provides compelling evidence for the effectiveness of STEM edutourism in promoting knowledge acquisition, positive attitudes, and increased motivation. By offering immersive experiences, exposure to real-world applications of STEM, and opportunities for comparative reflection, the Malaysia-Singapore science field trip facilitated meaningful learning and inspired participants to engage with STEM in deeper and more impactful ways.

Future research could explore the long-term impact of such programs and investigate how to tailor STEM edutourism experiences to meet the diverse needs and interests of participants. By continuing to bridge academic learning with experiential exploration, STEM edutourism holds immense promise for cultivating a future generation passionate about STEM and equipped to address global challenges.

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