Enhancing STEM Interest and Confidence Using Aiot Visual Programming Approach for University Service-Learning Outreach

Haw Yuan Kang[1], Zahriah Othman[2], Raja Rina Raja Ikram[3*], Nor Hafeizah Hassan[4], Abdul Karim Mohammad[5], Nor Aiza Moketar[6], Nurul Akmar Binti Emran[7], Shahrom Tumin[8], Norfazren Fateah Adnan[9], Carol Liao[10], Cecelia Fong[11], Farazawani Omar[12], Khairul Shukry Wahled[13], Nur Aizuddin Kariman[14], Waris Candra[15]

[1,2,3,4,5,6,7]Faculty Technology Maklumat Dan Komunikasi, University Technical Malaysia Melaka, Malacca, Malaysia

[8]ST Microelectronics, Muar, Malaysia

[9]Malaysia Semiconductor Industry Association, Penang, Malaysia

[10,11]Semi South East Asia, Singapore

[12]Negeri Sembilan State Education Department, Malaysia

[13]Melaka State Education Department, Malaysia

[14]Muar District Education Department, Johor, Malaysia

[15]Micro: Bit Educational Foundation

[*]Corresponding author

DOI: https://dx.doi.org/10.47772/IJRISS.2025.90300103

Received: 28 February 2025; Accepted: 03 March 2025; Published: 02 April 2025

ABSTRACT

Fostering interest and confidence in STEM (Science, Technology, Engineering, and Mathematics) is essential for developing future innovators. This study investigates the impact of integrating AIoT (Artificial Intelligence of Things) visual programming using micro: bit into a university service-learning outreach program to enhance primary school students' interest and confidence in STEM. The program provided students with hands-on experience in developing AIoT projects through visual programming, guided by university mentors. Pre- and post-event surveys were conducted to assess changes in students' perceptions, alongside feedback from teachers and mentors. The findings indicate a significant improvement in students' confidence and interest in STEM, with a shift from neutral or negative responses to strong agreement with STEM-related statements. Teachers reported positive learning outcomes, while mentors gained valuable teaching experience. These results highlight the effectiveness of combining AIoT, visual programming, and university service-learning in fostering interest and confidence in STEM education. The study contributes to ongoing efforts to promote STEM through interactive and experiential learning approaches.

Keywords: Micro: bit, University Service-Learning, STEM Education, Visual Programming, Artificial Intelligence of Things

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) education is critical in educating students for future employment in an increasingly technologically advanced society [1]. However, many students, particularly those from younger generations especially girls, fail to develop enthusiasm and confidence in STEM courses due to a lack of interesting and interactive learning opportunities. According to [2], students' interest in STEM courses falls as they move through their education, with involvement declining from 55% in 7-year-old to only 39% left in 13-year-olds. One important issue is a lack of hands-on, interactive learning opportunities, which can make STEM subjects appear abstract and difficult. Furthermore, a large gender disparity persists, with only 12% of females envisioning themselves in STEM jobs compared to 38% of boys, underlining the need for greater representation and support. Confidence is also important, as many students see STEM as difficult, which leads to self-doubt and disengagement [1].

A major concern is a lack of practical STEM activities, with more than 70% of students expressing a need for more hands-on learning and only 26% of General Certificate of Secondary Education (GCSE) students engaged in frequent practical work [2]. To address these challenges, innovative teaching approaches such as visual programming and Artificial Intelligence of Things (AIoT) have been introduced to make STEM learning more interactive and hands-on. Visual programming such as micro: bit make code editor, which uses graphical interfaces instead of text-based coding, simplifies the learning process and lowers the barrier to entry for beginners [3]. Meanwhile, AIoT integrates artificial intelligence with IoT devices, allowing students to explore real-world applications of technology [4]. One effective AIoT tool in STEM education is micro: bit, a small programmable microcontroller that allows students to learn coding, problem solving, and computational thinking through interactive projects [5], [6].

Several studies have explored the effectiveness of service-learning in promoting STEM interest among students [7], [8]. However, existing research has largely focused on general STEM interventions without integrating AIoT and visual programming as core components of the learning experience. Moreover, studies often overlook the role of mentorship dynamics and teacher involvement in such programs, leaving a gap in understanding how these factors influence student engagement and learning outcomes.

This study aims to bridge the gap in STEM education research by analysis the impact of AIoT, visual programming, and a university service-learning approach on students' interest and confidence in STEM. While service-learning is acknowledged as an effective educational strategy, limited research has explored its integration with AIoT and visual programming to enhance student engagement.

To address this gap, this research investigates a university service-learning initiative that integrates visual programming and AIoT using micro: bit to foster STEM interest and confidence among students. The initiative was structured as a collaborative learning event, where students participated as learners, teachers acted as facilitators representing their schools, and university mentors guided participants through micro: bit programming and problem-solving activities. By fostering an interactive and supportive environment, this initiative aimed to make STEM learning more accessible, engaging, and practical.

By evaluating pre- and post-event survey responses, this study assesses whether technology-enhanced university service-learning effectively improves students' motivation and engagement in STEM fields. The findings contribute to the expanding field of STEM education research by providing insights into the effectiveness of combining AIoT and visual programming with university service learning. Furthermore, this study emphasizes the role of mentorship in STEM education, making recommendations for future educational initiatives that will improve STEM learning experiences and encourage greater engagement among younger generations.

RELATED WORK

This section reviews relevant literature on visual programming in education, the role of AIoT in learning, and the benefits of university service-learning approach.

Science, Technology, Engineering, and Mathematics

Research on STEM education has consistently highlighted challenges in maintaining students' interest and confidence in STEM fields [7] and it is important for individual and societal advancement. It equips students with essential skills such as critical thinking, problem-solving, and technological proficiency, which are highly valued in today's job market [8]. According to the [9], employment in STEM occupations is projected to grow by 8.8% from 2019 to 2029, outpacing the average growth rate for all other fields.

Beyond career prospects, STEM education fosters innovation and creativity by encouraging students to develop solutions to real-world challenges. For example, students from Houston ISD's Young Women's College Preparatory Academy designed an app to monitor flood levels and deploy protective barriers, directly addressing local environmental concerns [10]. Additionally, STEM education plays a critical role in promoting inclusivity and diversity. Initiatives such as the [11] aim to empower young girls with confidence and skills, addressing the underrepresentation of women in STEM careers.

To summarize, investing in STEM education is critical for developing a competent workforce, propelling technical developments, and sustaining global competitiveness. STEM education ensures that people can make a meaningful contribution to tackling critical global concerns by encouraging creativity and diversity [12].

Visual Programming

Visual programming has emerged as an effective method to introduce students to coding and computational thinking [3]. Unlike traditional text-based programming, visual programming uses graphical blocks to represent code structures, making it more accessible for beginners [13]. Research has demonstrated that visual programming not only simplifies coding but also enhances students' motivation and problem-solving skills [14]. Research has demonstrated that visual programming platforms like Scratch, and micro: bit makecode editor effectively lower the barrier to entry for young learners and those without prior programming experience [15], [16].

Despite the advantages of visual programming, challenges remain in effectively teaching it to students. A study by [14] found that students often struggle with understanding core programming concepts, even when using visual programming tools. Additionally, it also highlighted that students experience increased anxiety when learning visual programming, particularly when tackling loops and conditional structures. To solve these issues, a university service-learning approach is adopted, in which university students guide younger learners in visual programming and computational thinking, resulting in an interactive and engaging learning experience. The study found that students who engaged in this active learning strategy exhibited significant improvements in academic performance compared to those who did not. This reinforces the value of hands-on and interactive learning in visual programming education. [17].

Artificial Intelligence of Things

The integration of Artificial Intelligence of Things (AIoT) in education has gained attention as an innovative way to improve learning experiences. AIoT blends artificial intelligence and IoT devices, allowing students to investigate real-world applications of smart technology [18]. For instance, the BBC micro: bit has been utilized to help primary school pupils understand machine learning by creating activity trackers that collect and analyze movement data, thereby fostering a deeper understanding of STEM concepts through hands-on learning [19]. One notable study is [20], this research investigated the impact of using the micro: bit device on students' motivation to learn programming. The findings indicated a significant increase in motivation and improved performance among students who utilized the micro: bit in their coursework. The study recommended incorporating AI technologies like micro: bit into curriculum to enhance the educational process and student engagement.

Those studies demonstrate the potential of integrating AIoT tools such as the micro: bit into educational settings to provide practical, hands-on experiences that enhance students' understanding of STEM concepts and increase their motivation to learn programming [21].

University Service-Learning

Service-learning has been widely recognized as an effective approach to improving STEM education. Research has shown that integrating service-learning into STEM courses enhances student engagement, STEM literacy, and academic performance [22]. For instance, a study [22] examined service-learning across STEM disciplines and found that students scored significantly higher in post-service assessments and achieved better academic results in service-oriented projects compared to traditional coursework.

Other than that, engaging students in real-world STEM applications, such as solving authentic problems for disadvantaged communities, fostering improvements in creative thinking, collaboration, and perseverance [23]. These findings support the notion that hands-on, real-world applications can significantly enhance student engagement and learning outcomes [24], [25].

Summarize of Review

The literature indicates that integrating visual programming, AIoT, and service-learning into STEM education can significantly enhance student engagement and learning outcomes. However, while existing studies have explored these topics individually, there is limited research on combining all three approaches in a single initiative. This study aims to fill that gap by examining how a university-led service-learning event incorporating visual programming and AIoT impacts students' interest and confidence in STEM fields.

METHODOLOGY

This section outlines the research design, materials and tools used, participant scope, event structure, data collection process, and university service-learning role in the study. A survey-based quantitative approach was employed, gathering feedback from students, teachers, and mentors to assess changes in STEM interest and confidence. The methodology details the survey structure, participant groups, and data analysis techniques used to interpret the results.

Overview of the Study Design

This study employs an event-based approach to evaluate the impact of the event on students' confidence and interest in STEM. The event called "ST GEMS x SULAM BOOTCAMP AND CHALLENGE" was organized at University technical Malaysia Melaka (UTeM) and aimed at fostering STEM engagement among primary school students through hands-on learning with micro: bit, an AIoT tool and the micro: bit make code, a visual programming software. The study follows an experiential learning model, integrating service-learning principles where university students act as mentors to guide participants.

Participants

The event was open to primary school students aged 10 to 12 years old, who participated in groups. Each group consisted of 4 students and 1 teacher, forming a total of 17 groups. Throughout the event, university students from UTeM served as mentors, providing guidance on micro: bit visual programming and AIoT applications such as configuring the micro: bit device, connecting each part of the device together and so on.

Materials and Tools

Each participating group was given essential materials and resources to help them construct their projects. The list of materials given is shown in Table I.

Table I. List of Materials and Tools

Item name	Item quantity
micro: bit devices	2 set
REKA: BIT device	1 set
ESP8266	1 set
Ultrasonic sensor	1 unit

Servo motor	1 unit
Traffic light module	1 unit
Crocodile clip	2 unit
LED light	3 unit
Grove wire	2 unit
HuskyLens	1 set

These materials formed the fundamental toolkit provided by UTeM. Participants could request additional components if needed to enhance their projects. They were also encouraged to use other materials like cardboard, plastic cups, and various household items to assist in designing and building their projects. For their final project, they must utilize at least a micro: bit as the primary element.

Event Structure & Phases

The event was structured into four main phases to provide comprehensive learning and practice experience for participants. Figure 1 shows the flowchart of the event structure.

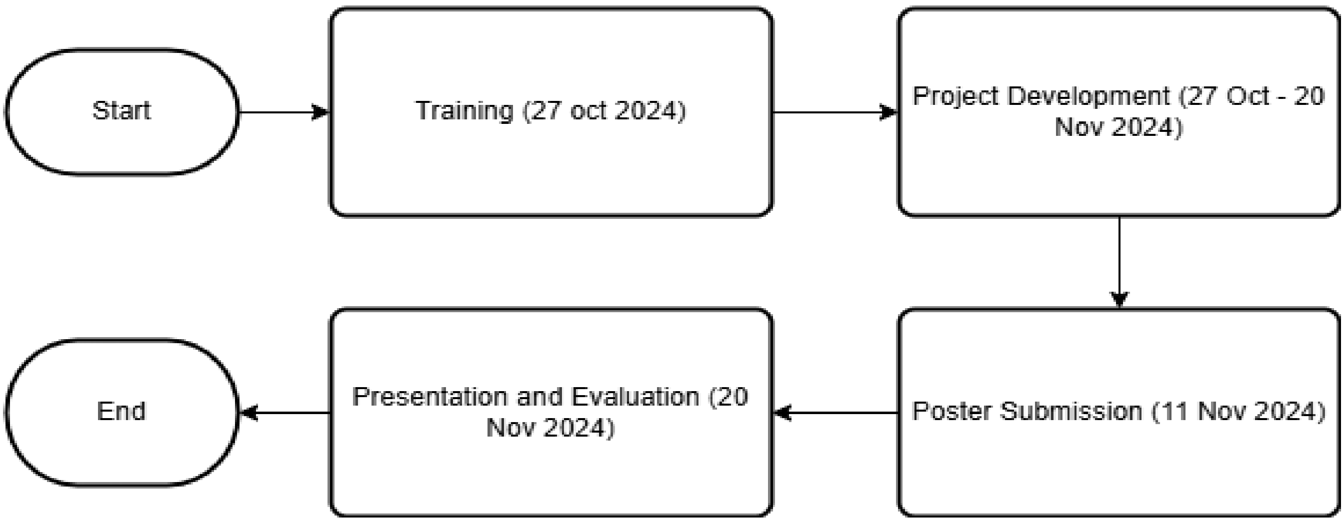

Figure 1. Flowchart of the event structure

The event began with the Training Phase on 27 October 2024, where all participants attended a one-day session at UTeM. During this session, UTeM students acted as mentors, guiding the school students through the fundamentals of micro: bit and micro: bit make code, a visual programming platform that made for micro: bit. This hands-on training introduced participants to the essential functions of micro: bit, allowing them to explore coding, test their projects, and troubleshooting errors in real time. Each group was assigned at least one mentor, who continued to support them throughout the event, providing guidance and answering any questions related to AIoT and visual programming.

Following the training, participants joined the Project Development Phase, which ran from 27 October to 20 November 2024. During this period, each group worked collaboratively to design and build their own innovative project using micro: bit, applying the knowledge gained from the training. UTeM mentors continued to assist participants via online sessions and in-person meetings, providing feedback and troubleshooting support to guarantee a smooth project development. This phase pushed students to think creatively, experiment with new ideas, and fine-tune their creations while actively interacting with STEM topics as they are interacting with visual programming and AIoT through the help of university service learning.

As part of their project submission, each group was required to prepare a poster outlining their work in the Poster Submission Phase, which took place on 11 November 2024. The A2-sized poster needed to include key elements such as a problem statement, details on the innovation of the project, a list of materials and tools used, a cost analysis, technical specifications, and an explanation of the project's benefits and impact. The posters were submitted in soft copy format to UTeM, who printed them for exhibition during the final evaluation.

The last phase of the event is the Presentation and Evaluation Phase, which was held on 20 November 2024 at UTeM. Figure 2 illustrates the flowchart of the last phase processes.

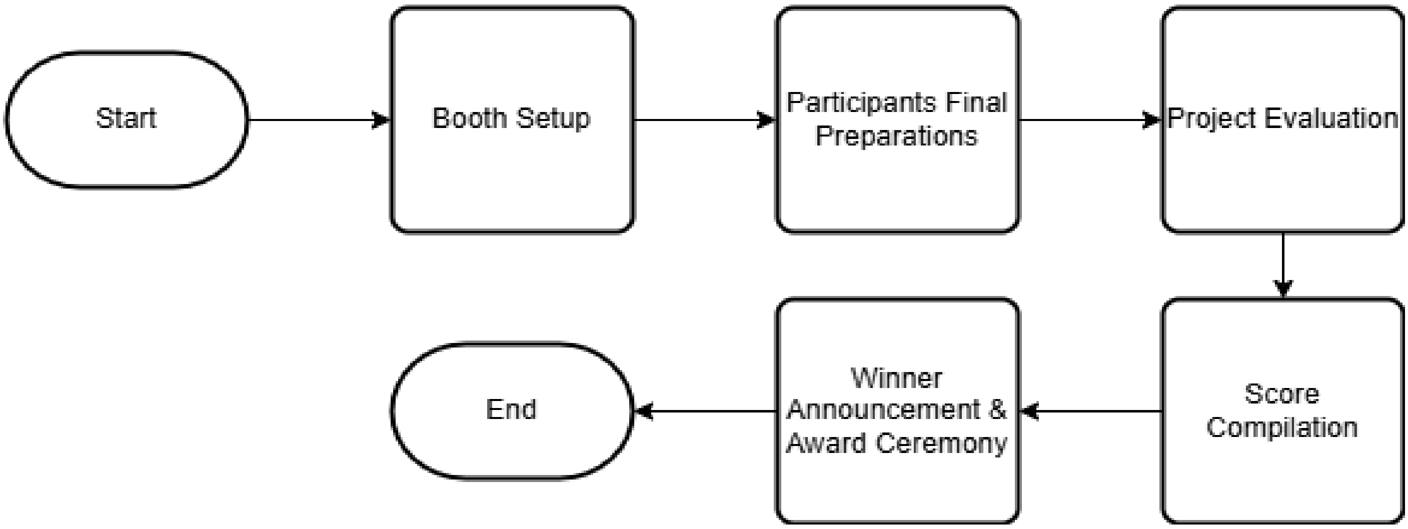

Figure 2. Flowchart of the presentation and evaluation phase

A panel of ten judges from industry and academia, evaluated the projects using particular criteria. These included the clarity of the problem statement, the effectiveness and feasibility of the solution, the impact and innovation of the project, the technical functionality of the prototype, the coding proficiency demonstrated, and the quality of presentation and teamwork. After the evaluation, scores were compiled to determine the winners, and the event concluded with an award ceremony, where prizes were presented to the top-performing teams and every other participant as well.

Role of University Service-Learning

A key component of this study was the incorporation of university service-learning, with UTeM students serving as mentors, guiding and assisting younger participants throughout the event. This technique created a collaborative learning environment in which students could explore, experiment, and build problem-solving abilities. Mentorship helped UTeM students improve their teaching skills while also strengthening their STEM knowledge through hands-on coaching and real-world applications. The presence of university students as mentors served as role models for primary school pupils, encouraging them to actively participate in STEM-related activities with improved confidence and excitement. This effort also promoted community engagement by bridging the gap between university resources and school instruction, ensuring that knowledge transfer went beyond classroom settings and into practical, effective learning activities.

Data Collection

This study used survey-based quantitative technique to evaluate the event's success in increasing students' confidence and enthusiasm in STEM. Data was gathered using Google Form surveys, which were spread to three participant groups: students, teachers, and mentors. Each group was given a tailored survey to evaluate their experiences, perceptions, and overall impact of the program. The number of responses collected was not predetermined but rather depended on the voluntary participation of individuals who chose to provide feedback.

The student questionnaire consisted of the following statements, where participants responded using a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). These statements were assessed both before and after the program to analyze changes in students' confidence and interest. Table II shows the list of questions that are sent to students to response.

Table II. Questionnaire List for Students

Questions	Descriptions
QS1	I like learning about science and technology
QS2	I am excited to learn how to use technological tools like micro: bit
QS3	I feel confident using new technology tools
QS4	I can program a device like the micro: bit to do things
QS5	I understand how sensors can detect things like light and movement
QS6	I know that coding tells devices what to do
QS7	I believe technology can solve real-life problems
QS8	I enjoy working on projects with my friends
QS9	I like to show my projects to others

These questions aim to measure students' interest in STEM, confidence in using technology, understanding of programming concepts, collaboration skills, and enthusiasm for sharing their work. The comparison between pre- and post-event responses helped determine whether the program had a positive impact on students' perceptions of STEM learning.

For teachers, a single survey was conducted after the event to gather their feedback. Their responses were based on a 5-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5) to evaluate their perceptions of the program's effectiveness. Table III shows the list of questions that are sent to teachers.

Table III. Questionnaire List for Teachers

Questions	Descriptions
QT1	Communication between university mentors and our school was clear and effective.
QT2	University mentors responded promptly to any questions or concerns.
QT3	There was strong collaboration between university mentors and our teaching staff.
QT4	I was well informed about event activities and student progress.
QT5	The resources and support provided were sufficient to implement the program effectively.
QT6	My students were highly engaged during the program activities.
QT7	Participation in this program increased my students' interest in STEM subjects.
QT8	The program helped improve students' problem-solving and critical thinking skills.
QT9	Using micro: bit technology enhanced my students' understanding of STEM concept.
QT10	Students showed increased confidence in tackling STEM projects after the program.
QT11	The program content was relevant to the students' curriculum.
QT12	The difficulty level of the program was appropriate for my students.
QT13	The program was well-managed and ran smoothly.
QT14	Participation in this program contributed to my professional development as an educator.
QT15	I would like to participate in similar programs in the future.

The teacher survey focused on evaluating communication with mentors, student engagement, curriculum relevance, resource adequacy, and professional development opportunities. It helped assess whether the program was effective in supporting STEM education and fostering student confidence.

For mentors, it is like a student's survey pattern where the question consists of pre and post events that need to be answered. Table IV shows the list of questions that are sent to mentors.

Table IV. Questionnaire List for Mentors

Questions	Descriptions
QM1	I feel that this program is relevant and necessary.
QM2	I had prior knowledge in the field related to this program.
QM3	I had a positive perception of the program.
QM4	I was able to gain the knowledge I expected from the program.

The mentor survey aimed to gauge their perception of the program's value, their preparedness, and whether they benefited from participating. This feedback provided insights into how well the mentoring process supported students and whether mentors found the experience valuable.

The collected responses were analyzed using descriptive statistics, with student responses categorized into pre- and post-event comparisons. Changes in confidence and interest levels were examined by comparing the distribution of responses across the Likert scale. Teacher and mentor feedback were analyzed separately to assess program effectiveness from an instructional and mentorship perspective.

This structured data collection approach ensures a valid and reliable assessment of how the event influenced STEM interest and confidence among students, while also capturing the perspectives of teachers and mentors on the effectiveness of the university service-learning approach.

FINDINGS & ANALYSIS

The findings derived from the collected data are presented in this section, along with an analysis of how the event affected students, teachers, and mentors. The analysis focuses on quantitative insights regarding participants' engagement, confidence, interest, and perception of STEM before and after the program.

Student Feedback Analysis

The analysis of student responses revealed a notable enhancement in their interest and confidence in STEM following their participation in the program. Feedback was provided by a total of 24 students. Figure 3 illustrates the level of student agreement on the survey questions before the program.

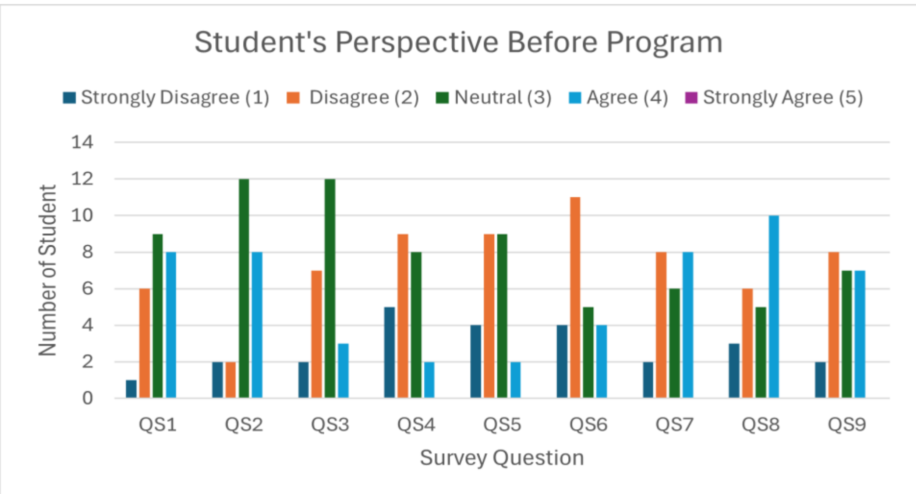

Figure 3. Student Responses Before the Program

Before participating in the program, students' responses reflected a mix of uncertainty and hesitation toward STEM education. Regarding their interest in STEM, nearly half of the students (45.8%) remained neutral, indicating that they were neither particularly interested nor uninterested in STEM-related topics. Only 34.4% expressed agreement that they liked STEM or enjoyed working on STEM-related projects, while 19.8% disagreed, suggesting a lack of enthusiasm toward the subject. Similarly, when examining confidence in STEM, the results revealed that many students (50.8%) were neutral, showing uncertainty about their ability to use technology and programming tools. Only 18.3% agreed that they felt confident in these areas, whereas 30.8% disagreed, indicating that many students felt unprepared or uncomfortable engaging in STEM education. These findings suggest that before the program, most students had an undecided stance on STEM, with a notable portion displaying hesitancy or a lack of confidence in their skills.

After the program, the level of student agreement on the survey questions is depicted in Figure 4 below.

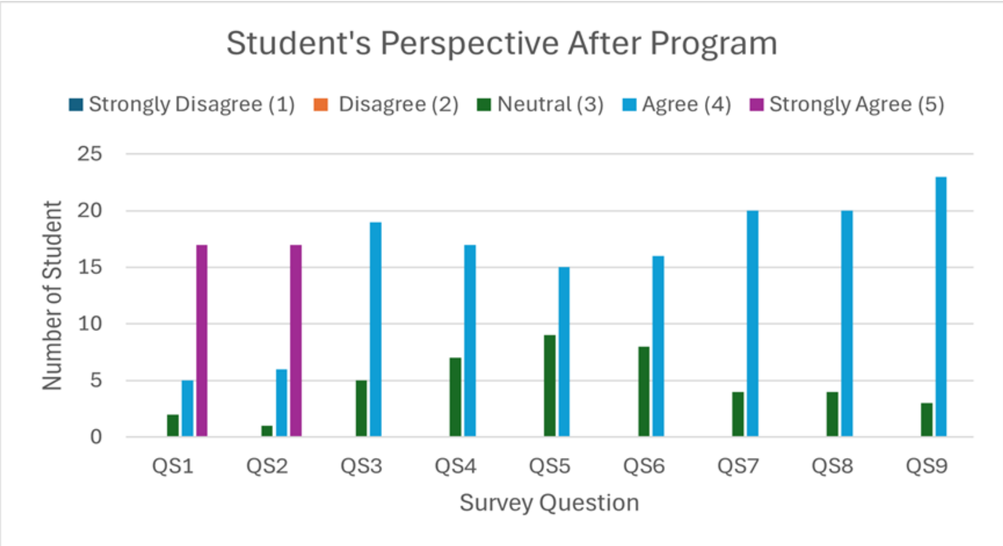

Figure 4. Student Responses After the Program

The results show a significant improvement in students' attitudes towards STEM. Most students chose 'Agree' or 'Strongly Agree' on all questions, with agreement rates ranging from 70.8% to 95.8%. Notably, no students chose 'Strongly Disagree' or 'Disagree,' indicating a total departure from negative or uncertain opinions. In terms of interest-related questions, at least 87.5% of students agreed, indicating a heightened excitement for STEM study and projects. Similarly, confidence-related responses improved significantly, with the lowest agreement rate at 70.8% and the highest at 95.8%, demonstrating that the curriculum successfully increased students' confidence in using technology and engaging with STEM ideas. This finding aligns with previous research suggesting that hands-on, technology-driven learning experiences can increase student motivation and self-efficacy in STEM fields [16], [17], [20].

Overall, these findings highlight the effectiveness of university service-learning in fostering student confidence and interest in STEM. The integration of AIoT and visual programming played a key role in making STEM concepts more accessible and engaging. Students demonstrated creativity in applying AIoT and visual programming to solve real-world problems. Some of the projects developed during the program include “AI Powered Car Arrival Recognition System”, “Smart Kiosk Books”, “Flood Alarm System” and so on. These projects highlight the students' ability to integrate coding, sensors, and problem-solving skills into their innovative ideas. By providing an interactive learning experience, the event successfully transformed student perceptions, encouraging them to explore STEM-related activities with greater enthusiasm and self-assurance.

Teacher Feedback Analysis

Feedback on the program was provided by a total of 17 teachers, representing each school involved in the participation. Unlike the student survey, teachers only provided feedback after the event, focusing on their observations and experiences. The results indicate a positive perception of the program's effectiveness, as most

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue III March 2025

teachers selected 'Agree' or 'Strongly Agree' for the provided statements, with agreement levels ranging from 76.5% to 100% across different aspects of the program. Specifically, more than 88% of teachers agreed that the program effectively engaged students in STEM learning, improved their confidence in technology use, and promoted hands-on problem-solving. These results align with studies emphasizing that integrating AIoT and visual programming fosters active learning and critical thinking [21], [23]. No teachers selected 'Strongly Disagree' for most questions, and only a small fraction (5.9% to 11.8%) chose 'Disagree' or 'Neutral' in a few cases, indicating minor reservations about certain aspects of the program. However, one teacher expressed dissatisfaction due to logistical challenges that prevented their assigned mentor from conducting in-person meetings with participants. While this highlights an area for improvement, the overwhelmingly positive feedback supports the effectiveness of integrating AIoT and visual programming in STEM education. The distribution of teacher responses to the survey questions is shown in Figure 5 below.

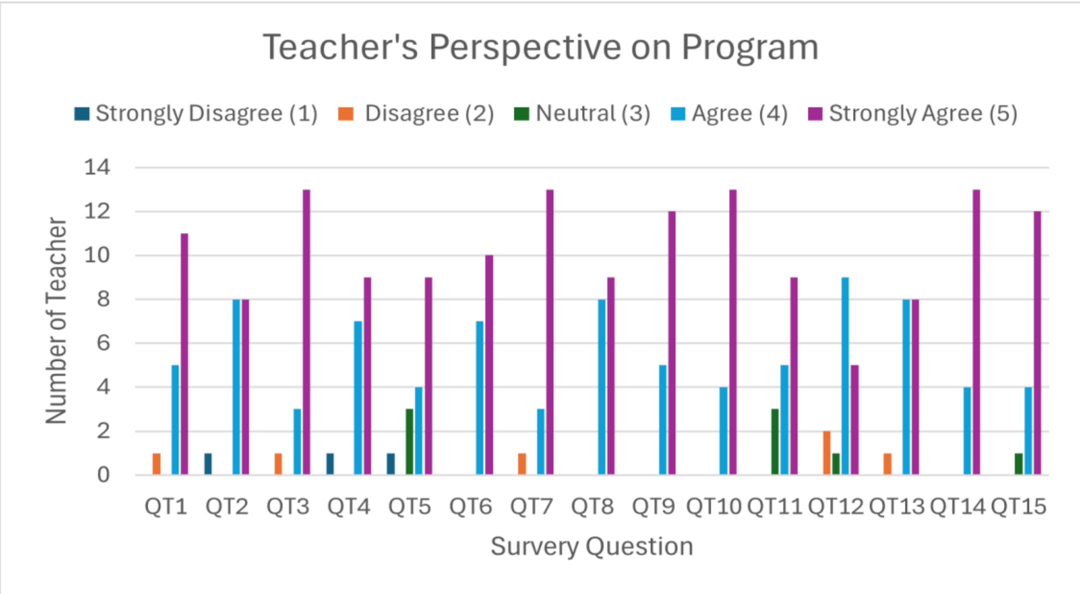

Figure 5. Teacher Responses on the Program

Mentor Feedback Analysis

A total of 26 mentors provided feedback on their experience supporting the participants throughout the program. Figure 6 shows the mentor's response before the program on the given statement.

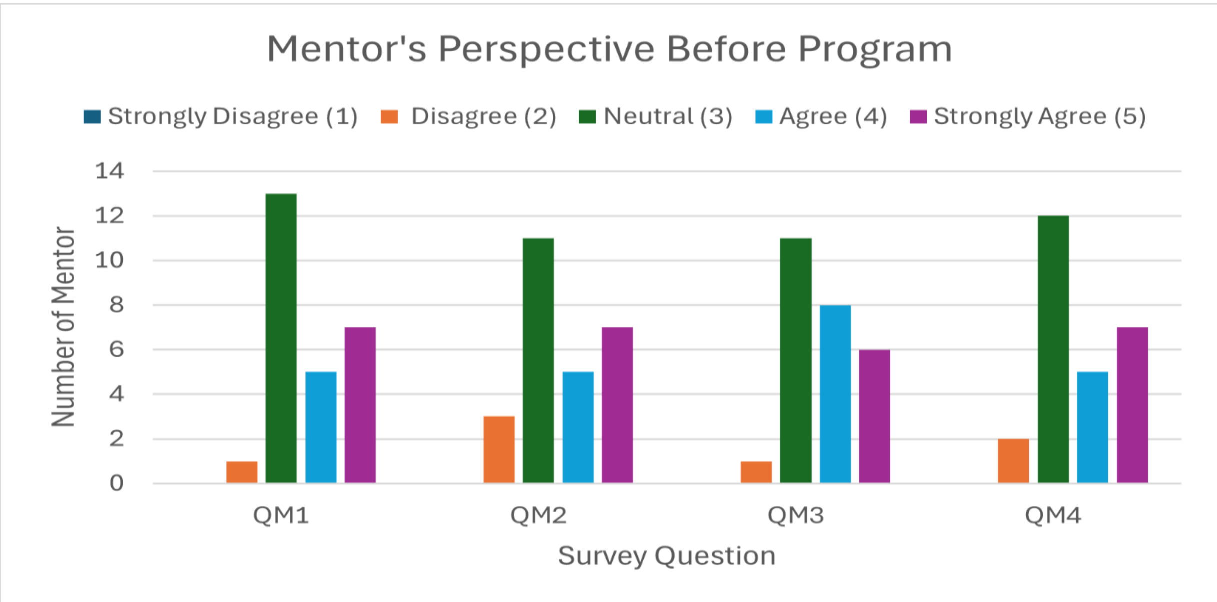

Figure 6. Mentor Responses Before the Program

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue III March 2025

Before the program, many mentors had a neutral stance (45.8% to 54.2%) on the survey questions given, indicating uncertainty about their role and expectations in the university service-learning approach. A minor portion (4.2% to 12.5%) of mentors disagreed with the statements, possibly due to concerns about time commitment or the effectiveness of mentorship. However, a significant number of mentors still selected ‘Agree’ (20.8% to 33.3%) and ‘Strongly Agree’ (25% to 29.2%), demonstrating that many were already confident in their ability to support students before the program began.

After the program, many mentors shifted their responses to ‘Agree’ (37.5% to 50%) and ‘Strongly Agree’ (45.8% to 54.2%), reflecting increased confidence and a more positive perception of their mentorship experience. Although a small portion (12.5% to 25%) of mentors remained neutral, there were no ‘Disagree’ responses after the program, indicating an overall shift towards a more favorable view of the service-learning approach. This highlights the effectiveness of service-learning in building mentorship confidence, aligning with existing research on the mutual benefits of mentorship in STEM education [25]. Figure 7 illustrates the mentor feedback distribution after the program.

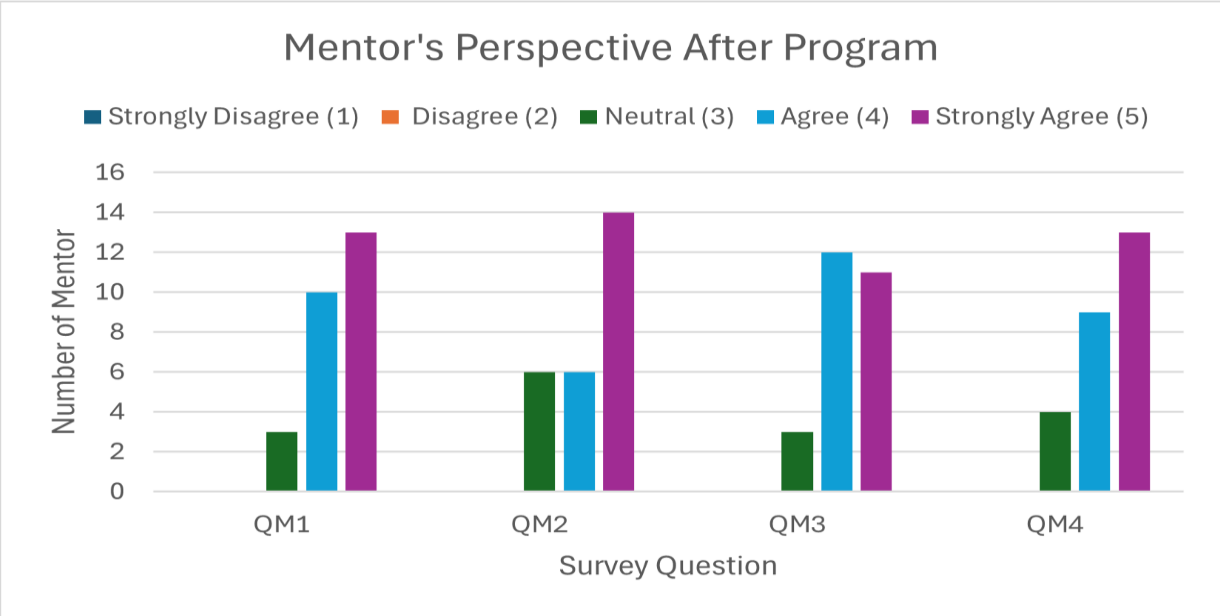

Figure 7. Mentor Responses After the Program

Summary of Findings

Survey responses from students, teachers, and mentors suggest that the “ST GEMS x SULAM Bootcamp and Challenge” positively influenced participants' confidence and interest in STEM.

First, students demonstrated a marked enhancement in their perception of STEM education after the program. Before participating, none (0%) of the students strongly agreed with the survey statements, and a significant portion (20.8% to 50%) remained neutral, while some expressed disagreement (up to 45.8%). However, following the program, the majority (70.8% to 95.8%) shifted to ‘Agree’ or ‘Strongly Agree’, reflecting increased confidence and enthusiasm for STEM learning.

Additionally, teachers also provided overwhelmingly positive feedback. According to the survey, 64.7% to 94.1% of teachers selected ‘Agree’ or ‘Strongly Agree’, indicating their recognition of the program’s effectiveness in engaging students, enhancing their confidence with technology, and promoting hands-on problem-solving. The overall response reinforced the value of integrating AIoT and visual programming in STEM education.

Not only that, but mentor responses also demonstrated a positive shift. Before attending the program, many mentors maintained a neutral position (45.8% to 54.2%), with some even expressing disagreement (up to 12.5%). After the program, responses increasingly leaned towards ‘Agree’ (37.5% to 50%) and ‘Strongly Agree’ (45.8% to 54.2%), with no mentors disagreeing (0%), highlighting the effectiveness of the mentorship experience.

In summary, these results suggest that the program successfully boosted student involvement, improved mentorship effectiveness, and strengthened teachers' roles in STEM education. The combination of visual programming, AIoT, and university service-learning created a significant and beneficial educational experience for everyone involved.

CONCLUSION

Through an interactive, hands-on educational experience, the program effectively fostered students' interest and confidence in STEM. By integrating visual programming, AIoT, and a university service-learning approach, the program provided students with meaningful engagement in technology while also strengthening mentorship and teacher participation. These findings reinforce the value of technology-enhanced learning in promoting active STEM involvement.

Future initiatives could focus on addressing challenges related to mentorship accessibility, ensuring that all students have equal opportunities for guided learning. Expanding participation in a broader demographic including different age groups, school types, or underserved communities could further enhance the inclusivity and impact of such programs. Additionally, longitudinal studies tracking students' continued engagement in STEM fields post-events would provide deeper insights into the lasting effects of hands-on, university service-learning approaches.

Programs like this play a vital role in motivating the next generation of STEM learners by fostering cross-disciplinary collaboration and real-world problem-solving skills. As AIoT and other emerging technologies continue to evolve, integrating them into education will be essential in preparing students for the demands of a technology-driven future.

ACKNOWLEDGEMENT

This research is supported by Faculty technology Maklumat dan Komunikasi, University technical Malaysia Melaka.

REFERENCES

1. J. Han, T. Kelley, and J. G. Knowles, "Factors Influencing Student STEM Learning: Self-Efficacy and Outcome Expectancy, 21st Century Skills, and Career Awareness," J STEM Educ Res, vol. 4, no. 2, pp. 117–137, Sep. 2021, doi: 10.1007/s41979-021-00053-3.
2. Tanya Weaver, "Girls' continued reduced interest in STEM a 'serious wake-up call,'" Engineering & Technology, Apr. 24, 2024. Accessed: Feb. 27, 2025. [Online]. Available: https://www.eandtmagazine.org/2024/04/24/girls-continued-reduced-interest-stem-serious-wake-call
3. T. D. Collins and P. Fung, "A visual programming approach for teaching cognitive modelling," Comput Educ, vol. 39, pp. 1–18, Jan. 2002, [Online]. Available: www.elsevier.com/locate/compedu
4. J. Zhang and D. Tao, "Empowering Things with Intelligence: A Survey of the Progress, Challenges, and Opportunities in Artificial Intelligence of Things," IEEE Internet Things J, Nov. 2020, [Online]. Available: http://arxiv.org/abs/2011.08612
5. K. T. Quyen, N. Van Bien, and N. A. Thuan, "Micro: bit in Science Education: A Systematic Review," Journal Penelitian dan Pembelajaran IPA, vol. 9, no. 1, p. 1, May 2023, doi: 10.30870/jppi.v9i1.19491.
6. S. Sentance, L. Yeomans, J. Waite, and E. MacLeod, "Teaching with physical computing devices: The BBC micro: Bit initiative," in ACM International Conference Proceeding Series, Association for Computing Machinery, Nov. 2017, pp. 87–96. doi: 10.1145/3137065.3137083.
7. S. Aslam, A. A. Alghamdi, N. Abid, and T. Kumar, "Challenges in Implementing STEM Education: Insights from Novice STEM Teachers in Developing Countries," Sustainability (Switzerland), vol. 15, no. 19, Oct. 2023, doi: 10.3390/su151914455.
8. H. De Loof, J. Boeve-de Pauw, and P. Van Petegem, "Engaging Students with Integrated STEM Education: a Happy Marriage or a Failed Engagement?," Int J Sci Math Educ, vol. 20, no. 7, pp. 1291–1313, Oct. 2022, doi: 10.1007/s10763-021-10159-0.

9. Global Education News, "The Importance of STEM Education in Today's World," GEN Read & Lead, May 17, 2023. Accessed: Feb. 27, 2025. [Online]. Available: https://globaleducationnews.org/the-importance-of-stem-education-in-todays-world/
10. Claire Partain, "These HISD students' homes flooded during Hurricane Harvey. Now, they're designing flooding solutions.," Houston Chronicle. Accessed: Feb. 27, 2025. [Online]. Available: https://www.houstonchronicle.com/news/houston-texas/education/hisd/article/hisd-stem-young-womens-school-20163195.php
11. Alissa Widman Neese, "New Girl Scouts STEM center is building confidence and skills," Axios Media, Ohio, Feb. 24, 2024. Accessed: Feb. 27, 2025. [Online]. Available: https://www.axios.com/local/columbus/2025/02/24/girl-scouts-stem-center-central-ohio
12. Muhammad Azli Riduan and Zarith Sofiah Othman, "Examining challenges and strategies in implementing STEM education in Malaysian secondary schools: perspectives of teachers and students," in Journal Intelek, Aug. 2024, pp. 96–106. doi: 10.24191/ji.v19i2.26514.
13. M. Noone and A. Mooney, "Visual and Textual Programming Languages: A Systematic Review of the Literature," ArXiv, vol. 2, Oct. 2017, doi: 10.1007/s40692-018-0101-5.
14. M. Paredes-Velasco, I. Lozano-Osorio, D. Perez-Marin, and L. P. Santacruz-Valencia, "A Case Study on Learning Visual Programming with TutoApp for Composition of Tutorials: An Approach for Learning by Teaching," IEEE Transactions on Learning Technologies, vol. 17, pp. 498–513, 2024, doi: 10.1109/TLT.2022.3226122.
15. J. Fagerlund, P. Häkkinen, M. Vesisenaho, and J. Viiri, "Computational thinking in programming with Scratch in primary schools: A systematic review," Computer Applications in Engineering Education, vol. 29, no. 1, pp. 12–28, Jan. 2021, doi: 10.1002/cae.22255.
16. V. Mardian and W. Azzahra, "A Review: The Impact of Micro: Bit-Assisted STEM Education," International Journal of Science Education and Teaching, vol. 3, no. 1, pp. 30–37, doi: 10.14456/ijset.2024.3.
17. Nurulsaidah Abdul Rahim and Suzaliza Mustafar, "Educational Strategy for Service-Learning using STEM Activities: A Case Study of a Malaysian Secondary School," ASEAN Journal of Community Engagement, vol. 8, no. 2, Dec. 2024, doi: 10.7454/ajce.v8i2.1313.
18. S. I. Siam et al., "Artificial Intelligence of Things: A Survey," ACM Trans Sens Netw, Jan. 2024, doi: 10.1145/3690639.
19. BBC, "How the micro: bit activity tracker was created," BBC Teach. Accessed: Feb. 27, 2025. [Online]. Available: https://www.bbc.co.uk/teach/microbit/articles/z932fdm
20. Amani Mohammed Omran Samaher Ahmed Al-Qarni, "The Effect of Artificial Intelligence (Microbit) in Raising the Motivation Towards Learning Programming Among the Students of Educational Technology at King Abdulaziz University in Jeddah," ResearchGate, Aug. 2021.
21. M. MILIĆ Profile Klett Doo Dario KUKULJAN and E. Krelja Kurelović, "The Eurasia Proceedings of Educational & Social Sciences (EPESS) The Eurasia Proceedings of Educational Micro: Bit Implementation in ICT Education," & Social Sciences (EPESS), vol. 11, 2018, [Online]. Available: www.isres.org
22. B. Blomstorm and S. Deboer, "STEM and service-learning: Does service-learning increase STEM literacy?," International Journal of Research on Service-Learning and Community Engagement, vol. 2, no. 1, pp. 32–43, 2014, [Online]. Available: https://journals.sfu.ca/iarslce/index.php/journal/article/view/61/23
23. B. Huang, M. S. Y. Jong, R. B. King, C. S. Chai, and M. Y. C. Jiang, "Promoting Secondary Students' Twenty-First Century Skills and STEM Career Interests Through a Crossover Program of STEM and Community Service Education," Front Psychol, vol. 13, Jul. 2022, doi: 10.3389/fpsyg.2022.903252.
24. S. N. D. Mahmud and N. K. Ismail, "STEM service learning in higher education: A systematic literature review," Eurasia Journal of Mathematics, Science and Technology Education, vol. 20, no. 12, 2024, doi: 10.29333/ejmste/15705.
25. M. Misiran, N. Ahmad, Z. Md Yusof, and M. Misiran, "Constructing STEM 3R Activity through Service-Learning Program during Movement Restriction," Asian Journal of Assessment in Teaching and Learning, vol. 12, no. 1, pp. 63–75, May 2022, doi: 10.37134/ajatel.vol12.1.7.2022.