

Workshop on Strengthening and Implementing STEM-Based Coding with ARTEC Japan-WOW Singapore - PPSTEMI: School Dissemination

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Article Info	Abstract
Article history: Received: May 18, 2024 Accepted: August 30, 2024 Published: January 27, 2025 Keywords: Critical thinking Creative thinking Collaboration Problem-solving STEM coding This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. © 2025 Bubungan Tinggi: Jurnal Pengabdian Masyarakat	Based on initial questionnaire data filled out by Mathematics and Natural Sciences teachers in Barito Kuala (Batola) Regency and Banjarmasin City, it was found that understanding and application of STEM Coding in schools is still low, so it is necessary to hold a STEM Coding community service workshop. This community service project aims to help participants develop critical thinking, creative, collaborative, and STEM literacy (4C) skills. The four stages of the community service method are planning, implementation, observation, and evaluation. A total of 127 teachers participated in the workshops. Speakers from PPSTEMI, Artec Japan, and WOW Singapore presented in the hybrid format event. The material consists of three modules: STEM-based learning, STEM Coding programming with Arduino Basic (Stop and Go), and Intermediate (Controlling a Motorized Car). Activities were evaluated using a response questionnaire, to which 127 people responded. The findings revealed that, on average, 95.47% of participants thought favorably of this STEM Coding exercise. Critical thinking, creativity, collaboration, and STEM literacy are among the skills that workshop attendees can acquire—wrapped up this STEM Coding workshop to help them become more STEM literate.
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INTRODUCTION

The Decree of the Minister of Education and Culture of the Republic of Indonesia Number 3/M/2021 concerning Key Performance Indicators (IKU) for State Universities and Higher Education Service Institutions under the Ministry of Education and Culture states that to improve the quality of service implementation, State Universities need to enhance curriculum quality and learning, one of which is through practitioners teaching

on campus (IKU 4), the utilization of lecturers' work by the community (IKU 5), and partnerships with world-class partners (IKU 6). These three indicators can be achieved through Community Service Activities in collaboration with partners from Japan and Singapore, namely Artec Japan, WOW Singapore, and PPSTEMI (Indonesian Science Technology Engineering Mathematics Enthusiasts Association).

The Faculty of Teacher Training and Education at Universitas Lambung Mangkurat (ULM) has made significant contributions to the development of Science, Technology, Engineering, and Math (STEM) by being involved in the PPSTEMI organization. The initial activities of this community service began with participating in a workshop held at Nanyang Technological University Singapore (NTU) in collaboration with the Directorate General of Teachers and Education Personnel in October 2023, followed by a STEM facilitator workshop in December 2023. These activities were the initial series of this Community Service program, culminating in a STEM workshop for elementary to high school teachers in the cities of Banjarmasin, Barito Kuala Regency, and Banjar.

The STEM approach integrates these four disciplines into a problem-based learning method ([Zaid et al., 2022](#)). Figure 1 shows that research often uses keywords such as STEM, STEAM (STEM enriched with the arts), STEM Education, computational thinking (CT), robotics, coding, etc. Concerning student development, STEM education emphasizes cognitive development (computational thinking, creativity, thinking steps, and metacognitive awareness) and 21st-century skills that students need to possess today.

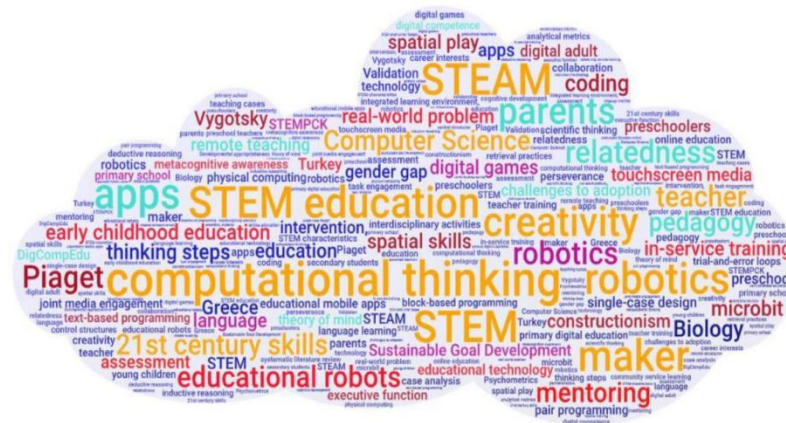


Figure 1 Cloud of research keywords (Papadakis et al., 2022)

STEM education has become an alternative learning method that can build a generation capable of facing the 21st century. The National Education Association identifies 21st-century skills as the "4C" skills, which include critical thinking, creativity, communication, and collaboration ([Aufa et al., 2021](#)). Mastery of STEM and its learning, as well as the integration of technology in Education 4.0 ([Maharani et al., 2019](#); [Yusoff et al., 2020](#)), is required to solve problems effectively and efficiently, including through the use of computational thinking ([Tsarava et al., 2019](#)). Today's students must master computational thinking to train thinking and problem-solving skills ([Putri et al., 2023](#); [Román-González et al., 2017](#)). Additionally, computational thinking equips students to think critically, rationally, and systematically ([Chongo et al., 2020](#); [Goyal et al., 2016](#); [Senin & Nasri, 2019](#)) and become lifelong learners.

Based on interviews and observations, the issues identified in this activity are: (a) the low understanding of teachers in Banjarmasin about STEM, (b) the implementation of STEM in some schools is still simple and utilizes basic materials such as mineral water bottles and ice cream sticks, not yet based on school coding equipment, and (c) the need

to conduct workshops for teachers to learn how to operate equipment that supports STEM-Coding.

This activity is an international collaborative community service involving foreign resource persons, namely Artec Japan and WOW Singapore. The activity aims to train students and PMIPA teachers in STEM coding to improve their STEM Coding literacy and the 4C skills of workshop participants.

According to Bybee (2011), the goal of STEM education is to produce STEM-literate students who are expected to have the knowledge, attitudes, and skills to identify questions and problems in their lives, explain natural phenomena, design and draw conclusions based on evidence related to STEM issues, understand STEM concepts and principles in an integrated way, and develop products, processes, and systems that benefit human life. For educators, the goal is to improve STEM content and enhance pedagogical content knowledge.

STEM-based learning becomes an approach to addressing real-world problems by guiding students' thinking patterns to become problem solvers, innovators, independent thinkers, logical thinkers, technology-literate, and able to connect educational institutions (schools) with the real world. The future will increasingly depend on advanced technology such as drones, robotics, industrial automation, smartphones, IoT (Internet of Things), etc.

STEM literacy refers to an individual's knowledge, attitudes, and skills to tackle real-life problems, explain phenomena and design, and draw conclusions from various facts related to STEM subjects ([Gonzalez & Kuenzi, 2012](#)). STEM literacy is related to computational literacy and coding. According to [Barron et al. \(2021\)](#) and [NAEYC \(2012\)](#), coding competence is crucial to be taught at all levels of education because almost all jobs in the 21st century require technology to make work more effective.

Coding literacy must be taught early ([Campbell & Walsh, 2017](#)) to activate thinking, communication, and expression of ideas. Through coding, children gain computational literacy to become producers rather than just consumers of digital artifacts ([Bers, 2020](#)). The application of coding learning in schools needs to be mastered by teachers because coding supports higher-order skills such as creative thinking, questioning, problem-solving, and critical thinking, which are considered essential in the scope of 21st-century skills related to computational literacy ([Çiftçi & Bildiren, 2020](#)).

Computational thinking has emerged as an essential skill in coding learning. As a new skill, theories on practicing it vary ([Aranda & Ferguson, 2018](#)). Innovative coding learning programs are adapted to the supporting facilities available in schools to stimulate students' computational thinking competencies from an early age.

Given the advantages of STEM Coding learning, computational thinking and coding should be taught early as skills children can use daily to solve problems. Stimulating children's skills involves using digital devices and enhances computational thinking, which helps understand, process, and develop children's cognition from an early age.

METHODS

The community service method involves four stages: planning, implementation, observation, and evaluation.

Planning. In October 2023, activity facilitators were prepared through a facilitator workshop at Nanyang Technological University (NTU) Singapore.

Implementation. The STEM Coding workshop using an Artec Japan toolkit was held in the Hasan Bondan Hall, FKIP ULM Banjarmasin. The participants comprised 160 people, including 127 offline participants (40 elementary, middle, and high school teachers, 24 students, and 63 lecturers) and 33 online participants from the PMIPA FKIP ULM

Department. The activity was conducted in a hybrid format. It included speakers from (1) PPSTEMI on STEM-based learning, (2) WOW Singapore on the Artec Robo 2.0 Teachers' manual, and (3) Artec Japan and Artec Indonesia on STEM and programming with Studuino. The material presented consisted of two modules, namely Basic 1: Stop and Go and Intermediate 1: Controlling Motor Cars. Further explanation was provided on the Artec curriculum from kindergarten to high school.

Observation. It involved observing participants during the activity and analyzing the results of response questionnaires using Google Forms.

Evaluation. The implementation of all community service activities was evaluated based on the response questionnaire data, which was then analyzed descriptively and quantitatively. This community service activity is expected to provide significant benefits in education.

RESULTS AND DISCUSSION

Some teachers were driving teachers, and the students would become future teachers. The lecturers involved have the potential to develop STEM in their respective subjects.

As part of the implementation of international cooperation between the PMIPA FKIP ULM Department, PPSTEMI (Indonesian Association of Science, Technology, Engineering, and Mathematics Enthusiasts), Artec Japan, and WOW Singapore, a STEM Coding Robotic workshop for teachers in the format of international collaboration-community service was held on Wednesday, January 24, 2024. The workshop was aimed at science, mathematics, IT, and craft teachers. The activity was conducted in a hybrid format, where the teachers practiced directly with tools from Artec Japan, conducting offline training at Hasan Bondan Hall, FKIP ULM, while other speakers and participants attended via Zoom conference.

This activity was also simultaneously carried out in 12 other universities in Indonesia to foster creativity among teachers and students in STEM-based learning. At FKIP ULM, this activity was carried out by JPMIPA in collaboration with UPKH (Unit of Cooperation and Public Relations) and received full support from the FKIP ULM leadership. The event took place from 08.00-17.00 WITA and began with remarks (Figure 2) from the Head of the Organizing Committee, Dr. Syahmani, M.Sc., and the Vice Dean 3 of FKIP ULM, Dr. Ali Rahman, M.Pd., who also officially opened the workshop.



Figure 2 Opening Remarks by the head of the organizing committee (Dr. Syahmani, M. Si) and vice dean 3 of FKIP ULM, Dr. Ali Rahman, M.Pd., at the STEM coding workshop

The speakers for this event were Arif Hidayat, Ph.D.Edu from PPSTEMI, Ms. Jane Soh from WOW Singapore, and Mr. Alex Groms from Artec Japan (Figure 3). A total of 40 teachers participated in coding practice to build interesting robotic installations. Participants included teachers from SMAN Banua in Banjar Regency, Global Islamic

Boarding School (GIBS) in Barito Kuala Regency, SMPN 1, SMPN 18, SMPN 32, SMAN 2, SMAN 3, SMAN 7, SMA Frater Don Bosco, SMK Muhammadiyah 3, SMA IT Ukhuwah, and several other schools in Banjarmasin City.



Figure 3 The speakers from PPSTEMI, WOW Singapore, and Artec Japan presenting their material

The next stage, which involved practical STEM Coding for assembling robots, was conducted offline at FKIP ULM Banjarmasin (Figure 4).



Figure 4 The Participants assembling toolkits and demonstrating them

The training participants were divided into small groups (each group consisted of 2 participants) to encourage collaboration and teamwork in assembling and operating the robots. The activities carried out by the participants included assembling robot parts, writing coding using Studuino and Python programming to give commands to the robot, and testing the robots on pre-prepared floors/tables. Due to its ease of use and high flexibility, Arduino Uno or Studuino is widely used by many, including beginners, to

explore the world of robotics. Before assembling the robots, participants were given a guidebook to help them understand the types of robot components, their functions, and how to assemble them.

At the end of the community service activity session, the committee gave participants a questionnaire to evaluate the implementation of the community service activities. This was followed by a group photo session with the committee and community service participants (Figure 5).



Figure 5 Assessment questionnaire and photo of the community service participants and teams

The event was successfully carried out due to the support from FKIP ULM, the solid teamwork from the committee from the PMIPA department, UPKH, and the participant support team. The enthusiasm and interest of teachers, lecturers, and students in this event were very high. The event was attended by 160 participants, consisting of 127 offline and 33 online participants. Based on the results of the community service target achievement survey (Table 1), the STEM Coding activity received an average positive response (good and very good) of 95.47%.

Table 1 Results of participants' responses to the STEM coding workshop

No	Statement	Percentage of Responses (%)				
		VP	P	M	G	VG
1.	The International STEM Coding community service training is beneficial for my professional development.	1.1	4.2	8.0	46.1	44.8
2.	The speaker provided a clear understanding of STEM Coding.	0	0	5.7	51.7	42.5
3.	The speaker gave concrete examples of using STEM Coding with the toolkit.	0	0	3.4	48.3	48.3
4.	The speaker delivered the material in a language that was easy to follow.	0	0	1.1	63.2	35.6
5.	The STEM Coding PkM training supports innovative learning and STEM literacy in schools.	0	0	2.3	41.4	56.3
6.	The International STEM Coding community service training is relevant for implementation in school education.	0	0	6.9	66.7	26.4
7.	I am interested in implementing STEM Coding in school education.	0	1.1	12.6	50.6	35.6
8.	The implementation of STEM Coding can facilitate teachers in training students' problem-solving skills.	0	1.1	4.6	54.0	40.2
9.	The implementation of STEM Coding can facilitate teachers in training students' critical thinking skills.	0	0	2.3	49.4	48.3

No	Statement	Percentage of Responses (%)				
		VP	P	M	G	VG
10.	The implementation of STEM Coding can facilitate teachers in training students' creative thinking skills.	0	0	3.4	44.8	51.7
11.	The implementation of STEM Coding in schools is seen as capable of equipping students with collaboration skills.	0	1.1	1.1	46.0	51.7
12.	Implementing STEM Coding is seen as capable of equipping students with communication skills.	0	0	1.1	59.8	39.1
13.	The International STEM Coding community service motivates and inspires participants/teachers to innovate and create.	0	0	3.4	47.1	49.4
14.	The service provided by the committee during the International STEM Coding community service was satisfactory.	0	0	1.1	49.4	49.4
15.	How about follow-up training activities?	0	0	3.4	43.7	52.9
Average		0.07	0.50	4.03	50.67	44.80

Information: VP= Very Poor, P = Poor, M = Moderate, G = Good, VG = Very Good

Briefly, the illustration of the achievement is above 90% (in Figure 6). This is reinforced by research findings ([Mujiarto et al., 2019](#); [Papadakis et al., 2022](#)) that learning robotics or STEM/STEAM Coding can foster students' creativity and computational thinking. In addition, it can provide a deep understanding of technological developments and increase students' interest in the STEM field ([Hozairi & Kurdianto, 2019](#)), enhance higher-order thinking skills, problem-solving, critical and creative thinking ([Hebebececi & Usta, 2022](#); [Syahmani et al., 2023](#)), collaboration and communication skills, primarily when they work together in designing and assembling tools, toolkits, or robots ([Nehru et al., 2023](#)). The results of the participant's responses are listed in Figure 6.

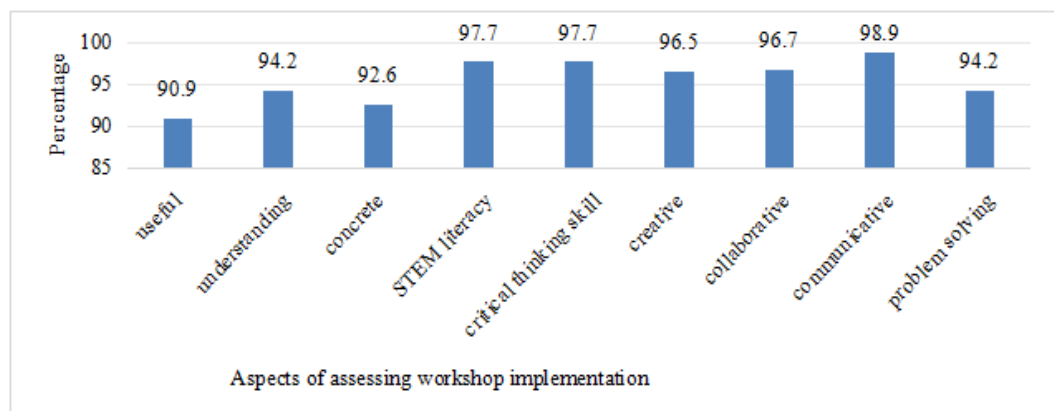


Figure 6 Results of the participant's responses

The Department of Mathematics and Natural Sciences of FKIP ULM is optimistic about continuing to collaborate. It is committed to developing STEM in Indonesia, especially in South Kalimantan, through a STEM research/study unit to facilitate various

STEM research, service, and training activities. Meanwhile, one of the participants, Niko Rahmad Aprilyanto from GIBS (Global Islamic Boarding School), expressed great enthusiasm for this event. "This event is exciting. If the teachers are interested, I can imagine what it would be like when this is tried with the children. I imagine a dynamic and collaborative class when applying something like this, but access to the tools (toolkit) is needed. The idea is to attract children to solve problems with basic coding, just like assembling a puzzle. But to arrange a problem-solving-based puzzle, logic must be developed. So it's not just playing but also problem-solving, which is very interesting for children," he said. Digital creativity toolkits can be used to integrate STEAM education in schools, develop aspects of problem-solving skills and creativity, and increase students' motivation and confidence ([Kalogiannakis et al., 2021](#)). To fully address these challenges, it is important to start engaging students from various communities in elementary, middle, and high schools and universities ([Estrada et al., 2016](#); [Ghazzawi et al., 2021](#); [Hulleman & Harackiewicz, 2009](#)) to build networks and support, develop diverse skills, and envision roles in a sustainable society in the future.

Impact of this community service activities:

1. Empower the community by integrating STEM Coding literacy, 4C skills, and resources so that participants can manage and improve their quality of life.
2. enhancing access to and quality of education in various countries.
3. building cooperation and collaboration between different countries and institutions.

This workshop has provided the following benefits: (1) developing problem-solving skills, (2) increasing creativity through programming or application creation, (3) mastering information and communication, (4) coding skills, (5) improving scientific and digital literacy, and (6) enhancing global competitiveness. STEM coding training provides a strong foundation for participants to engage in the modern world of science and technology, opening up broad career opportunities and contributing positively to developing a technology-based society.

CONCLUSION

The STEM Coding Workshop received positive responses from participants because it can improve understanding, STEM literacy, and 4C skills in schools. Concrete examples of STEM Coding can be implemented in classrooms, thus motivating and inspiring teachers to innovate and create in teaching. The STEM Coding workshop also helped teachers understand how to use tools to support coding-based STEM learning.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

For community service articles with multiple authors, a short paragraph stating the contributions of each should be included. The following statement should be used: "Conceptualization, SS, AW, and AIM; methodology, RR, and YDP; formal analysis, DD, MW, NW; Data collection, NF, NAS, RP, and MAK; writing—preparation of the original draft, YK, AS, APP, and HSP; Documentation, ERF and DA. All authors gave their approval to the final draft.

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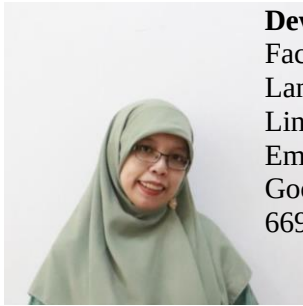
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