JOURNEY
JOURNAL OF TRAINING AND SOCIAL EMPOWERMENT FOR INDONESIAN SOCIETY
BIMA UTAMA PRESS

IMPLEMENTATION OF STEM LEARNING BASED ON SCRATCH CODING TO IMPROVE DIGITAL SKILLS AND CREATIVITY OF STUDENTS OF MUHAMMADIYAH 18 ELEMENTARY SCHOOL

Arief Budijanto[1], Rudianto[2]
[1,2]Computer Technology Department, NSC Polytechnic Surabaya, Surabaya, Indonesia
Email: ariefbdj212@gmail.com[1], rudiantomcs@gmail.com[2]

Article Info

Article history:

Received : 27 - 12 - 2024
Revised : 12 - 1 - 2025
Accepted : 16 - 1 - 2025

Keywords:

1. STEM
2. Coding Scratch
3. Innovative Education
4. Project Based Learning
5. Digital Skills
6. Elementary Students

Abstract

The era of globalization and digitalization requires the younger generation to have adequate critical thinking, creative, collaborative, and technological skills. To answer this challenge, the STEM (Science, Technology, Engineering, and Mathematics) learning approach based on Scratch coding is applied through community service activities at SD Muhammadiyah 18 Surabaya. This activity introduces STEM and coding concepts with an interactive and relevant project-based method.

The implementation method includes preparation, teaching coding with Scratch, project-based learning, and evaluation. Students are trained to create projects such as animations, educational games, and interactive stories, with guidance from teachers who are also given companion training.

The results showed increased students' understanding of STEM and coding concepts, high enthusiasm, and better critical, creative, and collaborative thinking skills. Teachers gained new insights into integrating coding learning into the curriculum. Some challenges, such as limited tools and varying levels of student understanding, require further development.

In conclusion, this activity has a positive impact on improving the quality of STEM and coding learning. It is the first step in developing innovative education at the elementary school level. Widespread implementation of similar programs can support the readiness of the younger generation to face the digital era.

Corresponding Author:

Arief Budijanto
Computer Technology Department
NSC Polytechnic Surabaya, Surabaya, Indonesia
ariefbdj212@gmail.com

1. INTRODUCTION

In the era of globalization and rapid digitalization, societies worldwide face significant transformations in various aspects of life. Digital technology has become the backbone of progress in multiple sectors, ranging from education (Yusuf, Julianingsih, & Ramadhani, 2023), health (Purba et al., 2024), economy (Maria & Widayati, 2020) to communication (Sari & Utami, 2021). In this context, education faces increasingly complex challenges, namely, preparing the younger generation to adapt and compete in a changing world. The world of work now demands individuals who not only have in-depth knowledge in one field but are also able to think critically, creatively, and collaboratively and have qualified technological skills (Ramzijah, Nazariah, & Fattah, 2024; Aryani, 2023).

STEM (Science, Technology, Engineering, and Mathematics) is one educational approach that can answer this challenge. STEM is an interdisciplinary learning approach that integrates science, technology, engineering, and mathematics to help students understand how concepts in these four fields can be applied to solve real problems (Suwardi, 2021) (Davidi, Sennen, & Supardi, 2021). With STEM-based education, students are equipped with theoretical knowledge and trained to think logically, analytically, and creatively when facing various challenges.

Within the framework of STEM education, coding or programming has become one of the most essential skills to master early on. Coding teaches students how the technology they use every day works and provides a foundation for systematic thinking that can be applied in various aspects of life. With coding, students learn to solve problems in a structured way, create innovative solutions, and think algorithmically (Lutfina & Wardhani, 2020). In addition, coding also provides opportunities for students to channel their creativity through creating animations, games, or interactive simulations.

The urgency of learning coding is increasingly felt when seeing that the world of work in the future will be dominated by technology. According to various studies, most jobs in the future will involve programming or other technological skills (Aghniya & Effendi, 2021). If the younger generation is not equipped with these skills, they risk falling behind in global competition and missing out on opportunities to contribute to the digital economy (Ayu, Soelitisjanto, & Hernawan, 2023). Without coding, students will also have difficulty understanding how increasingly complex technologies work, potentially becoming passive consumers rather than active innovators (Afifah et al., 2023).

Platforms like Scratch are very effective tools for introducing coding to students early on. Scratch is a visual programming environment for children and beginners (Rio, Fadli, & Abdiansyah, 2024). Scratch makes learning coding fun, intuitive, and interactive with a simple interface and code blocks that can be arranged like a puzzle (Nasution et al., 2024). Through Scratch, students can create creative projects such as games, animations, and digital stories, improving their technical skills and encouraging the development of imagination, collaboration, and communication.

Seeing the importance of mastering coding and its impact on the younger generation's future, the community service team held a "STEM Learning Based on Scratch Coding" activity at SD Muhammadiyah 18 Surabaya. This activity aims to introduce STEM concepts through coding media that is interactive, fun, and relevant to student needs. This activity equips students with coding skills and is designed to help them understand basic STEM concepts and how the interrelationships between science, technology, engineering, and mathematics can be applied in everyday life.

This activity also highlights the role of teachers in supporting STEM and coding-based learning. The service team provided training and mentoring by involving teachers at SD Muhammadiyah 18 to help them understand how STEM learning can be integrated with the existing curriculum. With this collaborative approach, the school is expected to continue the coding teaching program independently, even after completing the service activities.

Without a mastery of coding, the younger generation risks being unprepared for global challenges, trapped in a limited understanding of technology, and missing out on opportunities in the digital economy. Therefore, learning coding is no longer just an option but an urgent need in building superior, creative, and innovative human resources. By organizing this activity, we want to make a real contribution to equipping students with relevant skills, improving the quality of education at SD Muhammadiyah 18, and encouraging the implementation of STEM-based learning in other schools.

2. METHOD

The community service activity, "STEM Learning Based on Scratch Coding," at SD Muhammadiyah 18 Surabaya, was carried out through a series of stages designed to provide a comprehensive learning experience for students and involve teachers in the learning process. The following are the stages of activity implementation in detail:

1. Preparation Stage

This stage is the first step to ensure the activities go according to plan. Some of the activities carried out in this stage are:

a. **Lesson Plan Preparation**:
The team designed lesson plans that introduced STEM concepts, taught coding with Scratch, and supported project-based learning. These plans were developed to match the level of understanding of elementary students and support relevant learning outcomes.

b. **Making Learning Modules and Media**:
The learning modules are organized with engaging content, including an introduction to STEM, steps for using Scratch, and guidelines for completing simple projects. Supporting media, such as presentation slides and video tutorials, are also prepared to help deliver the material.

c. **Coordination with the School**:
The team met with the principal and teachers to harmonize the activities' objectives with the school curriculum. In this meeting, the technical implementation of the activities, including the schedule, time allocation, and facilities to be used, was also discussed.

d. **Provision of Supporting Devices**:
The team ensured that all the required hardware and software, such as laptops, projectors, and Scratch software, were available and functioning correctly. In addition, the classroom was prepared to be conducive to coding learning activities.

2. Activity Implementation Phase

This stage is the core of the community service activities. Each session is designed to provide students with an enjoyable and meaningful learning experience. Here are the details of the activities:

a. Socialization and Introduction to STEM and Coding

The team introduced STEM concepts through an interactive presentation. Students were invited to understand how science, technology, engineering, and math are interrelated and relevant in everyday life. Real-life examples, such as how technology is used in making robots, weather simulations, or math applications in technology, were presented to capture students' interest. Students were also introduced to the importance of mastering coding in the digital age, including how coding can be used to create innovative solutions. This activity motivates students to consider coding an essential and enjoyable skill.

b. Introduction to the Scratch Platform

The team teaches the basics of using Scratch, including getting to know the interface, creating sprites (characters), and putting together blocks of code to execute commands. Students can experiment with basic code blocks, such as moving sprites, changing colors, or playing sounds. As an initial exercise, students are asked to create a simple animation, such as a sprite walking on the screen or a short, interactive story. This activity aims to equip students with basic coding skills using Scratch as an interactive learning tool.

Figure 1. Scratch Introduction

c. Project-based Learning

Students are divided into small groups (4-5 people) to work on a project together. Each group gets a different theme, such as:

- Simulate planetary movements to understand science concepts.
- Math games to practice addition or subtraction skills.
- Animations about everyday life that incorporate STEM elements.

The service team is a facilitator who provides direction if students experience technical difficulties or need additional ideas. Students are asked to record their steps during project creation to practice documentation of the learning process. This activity encourages students to think creatively, solve problems, and work in teams to produce STEM-based work.

d. Project Presentation and Reflection

Each group presented the results of their project in front of their classmates and the teacher. The service team provided feedback on the creativity, the project's relevance, and the students' technical skills. A reflection session was conducted by asking students questions about what they learned and what difficulties they experienced. Teachers are also invited to discuss and provide input regarding the activities that have been carried out. This activity aims to train students to speak in public, reflect on learning experiences, and receive constructive feedback.

3. Evaluation and Follow-up Stage

Evaluation was conducted to assess the success of the activities and their impact on students and teachers. Several steps were taken:

a. Project Outcome Evaluation

The team observed the students' projects based on their creativity, innovation, and understanding of STEM and coding concepts. The best projects are given appreciation to increase student motivation.

b. Discussion with Teacher

The team discussed with teachers to evaluate the implementation of the activity, listen to feedback, and provide recommendations for implementing independent coding learning in schools. Teachers are provided with additional training to ensure they can continue Scratch learning on an ongoing basis.

c. Follow-up Plan

The team suggested follow-up activities, such as advanced coding workshops or integration of Scratch in science and math subjects. Written guidelines are left to teachers to ease the implementation of STEM learning in the future.

This method is designed to have the maximum impact on students and teachers and to encourage the continuous integration of STEM education at SD Muhammadiyah 18 Surabaya.

4. RESULT DAN DISCUSSION

The "Scratch Coding-Based STEM Learning" activity at SD Muhammadiyah 18 Surabaya showed positive results in student understanding, teacher involvement, and the impact on the development of STEM and coding-based learning in the school environment. The following is a more in-depth description of the results and discussion:

1. **Improving Students' Understanding of STEM and Coding**

   This activity successfully improved students' understanding of STEM concepts, which include science, technology, engineering, and math. Through interactive socialization sessions, students can recognize the interrelationships between these four fields in everyday life, such as using technology in science experiments or applying mathematics in programming. Using the Scratch platform as a coding learning tool makes it easier for students to understand basic programming logic, such as sequence, loop, and condition.

2. **Student Project Results**

   Students completed various coding-based projects using Scratch. The projects were designed to integrate relevant STEM elements. Examples of project outcomes include:

   - **Planetary Movement Animation**

     This project depicts the orbits of planets in the solar system by utilizing code blocks for circular motion. The project involves science (astronomy) and technology (programming) elements.

   - **Math Educational Game**

     An interactive game that tests students' addition and subtraction skills through self-designed challenges.

   - **Interactive Story about the Environment**

     This project combines narrative and animation creativity to educate classmates about the importance of keeping the environment clean.

Figure 2. Project-based Coding Teaching

3. **Student Engagement and Enthusiasm**
During the activity, students showed a high level of engagement. They actively asked questions, discussed in groups, and experimented with various Scratch features. Some students added creative features beyond the instructions, such as sound effects or interesting transitions. This enthusiasm shows that the project-based approach created a fun learning environment and motivated students to think creatively.

Figure 3. Students' Enthusiasm in Scratch Learning Activities

4. **Collaboration with Teachers**
SD Muhammadiyah 18 teachers also actively participated in accompanying students during the activity. In addition to supporting students in the learning process, teachers also learned the basic techniques of teaching coding using Scratch. Post-activity discussions with teachers resulted in important input regarding integrating coding learning into other subjects, such as math and science.
5. **Positive Feedback from All Parties**
Based on surveys and informal interviews conducted after the activity, students and teachers responded positively to this activity. Students felt that they gained engaging new experiences, while teachers felt this activity provided insights into innovative learning methods that can be applied in the classroom.

Some of the things that are emphasized in this service activity are as follows:

1. **Effectiveness of the Project-Based Learning Approach**
   A project-based learning approach has been proven effective in increasing student engagement during the learning process. Students learn to apply STEM concepts in a real context through self-designed projects, develop critical thinking skills, and solve problems independently. This approach also trains students to collaborate, share ideas, and make decisions.
2. **The Importance of Early Coding Learning**
   Coding is an essential skill in the digital age. It is helpful for jobs in technology and trains logical and systematic thinking. In this activity, students learn the basics of coding through Scratch, a platform specifically designed for children. Scratch allows students to understand programming concepts without complicated syntax, making learning fun. If coding learning is not introduced early on, students risk falling behind in developing digital skills, which are increasingly becoming a demand in the modern workforce.
3. **Challenges Faced**
   Several challenges arose during the activity, including:
   - **Time Limitations**
     With the limited duration of the activities, students did not have enough time to develop more complex projects.
   - **Variation in Students' Comprehension Level**
     Not all students have the same technological abilities, so some need more intensive guidance.
   - **Device Limitations**
     Although the school has technology facilities, some students have to share devices with their friends, which slightly hinders the process of individual exploration.
4. **Teacher Support for Sustainability**
   The sustainability of STEM and coding learning is highly dependent on the role of the teacher as the primary facilitator. In discussions with teachers, it was agreed that further training is needed to teach coding independently. In addition, the integration of coding into other subjects, such as math and science, must be designed with an appropriate curriculum to keep learning relevant and purposeful.
5. **Recommendations for Future Program Development**
   - **Scope Expansion**
     This program can be expanded to other classes or schools to have a broader impact.
   - **Longer Time Allocation**
     Students can complete more complex and in-depth projects with a longer duration of activities.
   - **Procurement of Additional Devices**
     Schools must provide additional tools to support learning so each student can learn independently.
   - **Teacher Training**
     Intensive teacher training must be conducted to sustainably integrate coding learning into the school curriculum.

This activity provides direct benefits in the form of increased student understanding of STEM and coding and becomes the first step in building a culture of innovative learning in schools. With consistent support from all parties, this program has great potential to be implemented more widely and sustainably, preparing Indonesia's young generation to face global challenges with relevant skills.

5. CONCLUSION

The activity "STEM Learning Based on Scratch Coding" at SD Muhammadiyah 18 Surabaya was successfully implemented with positive results. This activity provides a meaningful learning experience for students and opens teachers' insights into the importance of STEM and coding integration in learning in elementary schools.

Students showed a better understanding of STEM and coding concepts and high enthusiasm for following the project-based learning process. They produced various creative works using Scratch, such as animations, educational games, and interactive stories, demonstrating improved critical thinking, creativity, and teamwork skills. The project-based approach effectively engaged students and increased their motivation to learn.

For teachers, this activity provided new insights into innovative learning methods. Evaluation discussions with teachers resulted in important recommendations for program sustainability, such as further training and coding integration into the existing curriculum. However, some challenges remain to be considered, such as time constraints, variations in students' level of understanding, and the availability of supporting tools.

This activity benefits students and teachers and becomes a strategic first step to developing STEM and coding-based education at SD Muhammadiyah 18. Hopefully, similar programs can be expanded to other schools and supported with adequate resource allocation. Thus, Indonesia's young generation will be better prepared to face the challenges of the digital era and become creative, innovative, and globally competitive individuals.

REFERENCES

Afifah, N., ML, D. A., & Nuryadin, A. (2023). Pengembangan Bahan Ajar Pemrograman Berbantuan Scratch pada Materi Operasi Hitung Bilangan Cacah Kelas V SD. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *8*(2), 1117-1127.

Aghniya, W., & Effendi, H. (2021). Perancangan E-Test dengan Menggunakan Learning Management System pada Mata Kuliah Pengantar Coding di Universitas Negeri Padang. *Jurnal Pendidikan Tambusai*, *5*(2), 5355-5364.

Aryani, N. P. D. E. (2023). Strategi Manajemen Perubahan Melek Teknologi dalam Membangun UMKM Technopreneur. *Jurnal Manajemen dan Ekonomi (JME)*, *1*(2), 81-90.

Ayu, V., Soelitisjanto, B., & Hernawan, H. A. (2023). Pelatihan Pemrograman Visual dengan Scratch untuk Siswa SD Negeri Sawah Panggang. *Jurnal Pengabdian Nasional (JPN) Indonesia*, 4(2), 277-283.

Davidi, E. I. N., Sennen, E., & Supardi, K. (2021). Integrasi Pendekatan STEM (Science, Technology, Engeenering And Mathematic) untuk Peningkatan Keterampilan Berpikir Kritis Siswa Sekolah Dasar. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, *11*(1), 11-22.

Lutfina, E., & Wardhani, A. K. (2020). Pengenalan dan Pelatihan Pemrograman Berbasis Blok bagi Anak. *Magistrorum Et Scholarium: Jurnal Pengabdian Masyarakat*, *1*(1), 107-111.

Maria, N. S. B., & Widayati, T. (2020). Dampak Perkembangan Ekonomi Digital terhadap Perilaku Pengguna Media Sosial dalam Melakukan Transaksi Ekonomi. *JKBM (Jurnal Konsep Bisnis Dan Manajemen)*, *6*(2), 234-239.

Nasution, N., Nasution, F. B., Hasan, M. A., & Al Fajar, M. (2024). Membangun Keterampilan Digital: Pelatihan Penggunaan Scratch di SMK Negeri 8 Pekanbaru. *Jurnal Pemberdayaan Sosial dan Teknologi Masyarakat*, *4*(1), 20-27.

Purba, N. F., Annisa, F. S., Syafitri, A., & Purba, S. H. (2024). Pemanfaatan Teknologi Digital dalam Pelayanan Kesehatan Publik: Sebuah Tinjauan Analisis Kebijakan. *Jurnal Kesehatan Unggul Gemilang*, *8*(6).

Ramzijah, R., Nazariah, N., & Fattah, A. (2024). Literasi Digital di Universitas Jabal Ghafur Pidie: Membangun Generasi Muda yang Melek Teknologi. *Konferensi Nasional Literasi Digital dan Kerelawanan*, *2*, 1-6.

Rio, R., Fadli, M., & Abdiansyah, A. (2024). Pengenalan dan Pelatihan Algoritma Pemrograman Menggunakan Aplikasi Scratch untuk Siswa SMP Kota Lubuklinggau. *Madaniya*, *5*(4), 2319-2327.

Suwardi, S. (2021). STEM (Science, Technology, Engineering, and Mathematics) Inovasi dalam Pembelajaran Vokasi Era Merdeka Belajar Abad 21. *PAEDAGOGY: Jurnal Ilmu Pendidikan dan Psikologi*, *1*(1), 40-48.

Yusuf, M., Julianingsih, D., & Ramadhani, T. (2023). Transformasi Pendidikan Digital 5.0 Melalui Integrasi Inovasi Ilmu Pengetahuan dan Teknologi. *Jurnal MENTARI: Manajemen, Pendidikan dan Teknologi Informasi*, *2*(1), 11-19.