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# Enhancing Digital Literacy and Computational Thinking through Scratch-Based Learning

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***Abstract:*** In the digital era, students must develop digital literacy and computational thinking skills to face technological challenges. However, many Indonesian schools still emphasize theoretical knowledge rather than practical applications. This community service program aimed to enhance these skills through Scratch-based learning at the Muslihun Foundation, Parung, Bogor Regency. The program involved 21 junior and senior high school students and was implemented in five stages: preparation, socialization, Scratch training, project mentoring, and evaluation. Using a Project-Based Learning (PjBL) approach, students learned to create animations and educational games that applied computational concepts creatively. The evaluation used a 10-item pre-test and post-test instrument measuring basic digital literacy, logic, sequencing, and problem-solving indicators. The average score increased from 62.86 to 98.10, representing a 56% enhancement. Most participants achieved perfect post-test scores, proving the effectiveness of Scratch-based learning in improving computational thinking, creativity, and engagement. These findings highlight the need for accessible hands-on digital learning models and demonstrate the potential of simple visual programming tools to strengthen inclusive digital education practices in Indonesia.

***Keywords:*** Computational Thinking; Digital Literacy; Project-Based Learning; Scratch

## 1. INTRODUCTION

Literacy is generally defined as the ability to read and write (Siregar, 2024). In the context of community empowerment, literacy refers to the ability to obtain, interpret, and use information effectively for personal and collective benefit (Khairiyati et al., 2024). Literacy plays a key role in fostering knowledge and creativity, especially in the digital era where information is abundant and rapidly accessible. Digital literacy encompasses the ability to access, understand, and utilize knowledge from various digital sources, which has become increasingly important as technology is integrated into learning environments (Devi & Winangun, 2024).

Another essential 21st-century skill is computational thinking, defined as a systematic approach to problem-solving that emphasizes logical structuring, pattern recognition, and algorithmic formulation

(Nurdalilah et al., 2025). Scratch, as a block-based visual programming platform developed by MIT Media Lab, provides an accessible medium for introducing these skills while encouraging creativity and collaboration among learners (Resnick et al., 2009; Grover and Pea, 2019).

Despite its importance, learning related to digital literacy and computational thinking in many Indonesian secondary schools is still dominated by theory, limited practical exposure, and minimal opportunities to apply concepts through creative, project-based digital activities. Students rarely engage in hands-on programming experiences that allow them to internalize algorithmic thinking in meaningful ways. This gap highlights the lack of inclusive, low-barrier, and practice-oriented digital learning interventions that can be accessed particularly by underprivileged students.

To address this gap, the main objective of this study is to enhance students' digital literacy and computational thinking skills through a Scratch-based community training program using a Project-Based Learning (PjBL) approach. The Muslihun Foundation in Parung, Bogor Regency, mentors underprivileged students with limited access to structured digital learning opportunities. By linking the identified gap with a practical community-based Scratch training program, this activity introduces a novel approach that combines PjBL, visual programming, and empowerment of disadvantaged learners, offering a model that promotes digital inclusion and helps prepare students for future technological challenges. This initiative is expected to provide equitable opportunities for students to develop essential 21st-century skills while supporting broader efforts toward inclusive digital education.

## 2. METHOD

The community service program was implemented through five stages—preparation, socialization, Scratch training, project mentoring, and evaluation—and was conducted in a single day with a total duration of approximately **2 hours and 30 minutes**. The complete procedure, timeline, and technical details are presents to ensure reproducibility (Figure 1).

### 2.1. Preparation

Coordination with the Muslihun Foundation regarding schedules, participant availability, and classroom facilities, preparation of laptops and installation of **Scratch 3.0 (offline editor)**, development of a learning module covering basic Scratch interface, animation and sprite manipulation, sequencing, loops, conditionals, and variables, and final mini-project development; administration of a **10-item multiple-choice pre-test** to assess students' initial digital literacy and computational thinking skills. Devices used are l**aptops with minimum specifications (**Intel i3 processor, 4GB RAM, offline Scratch 3.0) and one laptop per group (2–3 students).

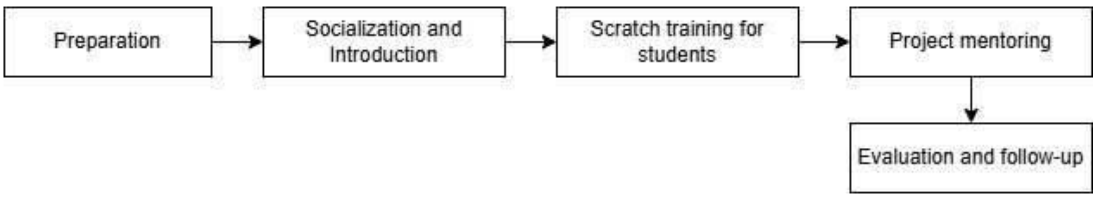


**Figure 1.** Stages of the Scratch-Based Learning Implementation Model

### 2.2. Socialization

Introduction to digital literacy and computational thinking in the context of everyday problem-solving., demonstration of Scratch 3.0's interface, block categories, and basic functions., short practical task: creating a simple sprite movement animation.

### 2.3. Scratch Training

This stage used the **Project-Based Learning (PjBL) approach**, selected because it situates learning within real, meaningful digital products (e.g., animations, games). It encourages collaboration, creativity, and iterative problem solving—core aspects of computational thinking; scratch is inherently suited for PjBL because students learn concepts while building artifacts; training activities included introduction to programming concepts (sequence, loop, condition, events, variables), animation development, educational game development, and continuous guidance by facilitators from the university team.

### 2.4. Project Mentoring

Students worked on a **final mini-project** (animation or educational game) and projects were evaluated using a structured rubric consisting of **Logic and functionality (40%)** – correct use of sequence, loops, and conditionals; **Creativity and design (30%)** – originality, visual quality, sound usage; **Completeness (20%)** – presence of instructions, start/end mechanisms; and t**eam collaboration (10%)** – contribution and group coordination

### 2.5. Evaluation and Post-Test Assessment

A **10-item multiple-choice post-test**, parallel in structure to the pre-test, was administered. Test indicators included digital literacy fundamentals, logical sequence recognition, basic algorithmic reasoning, understanding of loops and conditionals. Score improvements were analysed descriptively to identify learning gains. The percentage improvement was calculated using a standard formula commonly applied in educational intervention studies (Creswell, 2018) (Fraenkel & Wallen, 2019), namely:

$$Improvement\ (100\%) = \frac{Post\ Test - Pre\ Test}{Pre\ Test}\ x\ 100 \qquad \text{Equations (1)}$$

Teacher feedback and participant reflections were also collected to assess sustainability.

## 3. RESULT AND DISCUSSION

The community service activity focused on strengthening students' digital literacy and computational thinking skills through structured Scratch-based training. A series of evaluations—from pre-test, training observations, project mentoring, and post-test—were conducted to assess learning progress and engagement. A total of 21 students participated in the full program. Before activities began, students completed a **10-item multiple-choice pre-test** on digital literacy and computational thinking. **Figure 2** illustrates participants completing the pre-test under supervision.

**Figure 2.** Participants completing the pre-test

The average pre-test score was **62.86**. Following the introductory session on the importance of digital literacy and computational thinking, students proceeded to the workshop. During the workshop, students practiced creating simple animations and games using Scratch 3.0 in small groups, as shown in **Figure 3**. Their enthusiasm remained high throughout the practice sessions. In the subsequent hands-on activity, participants developed a mini digital game project using Scratch. **Figure 4** depicts the mentoring process, where facilitators assisted participants in applying programming concepts such as loops, conditions, events, and variables.

**Figure 3.** Presentation and demonstration session on digital literacy and computational thinking

At the end of the workshop, the **post-test**—also consisting of 10 multiple-choice items—was administered. The post-test results demonstrated substantial improvement. The average score increased from **62.86 (pre-test)** to **98.10 (post-test)**. Percentage improvement was calculated as follows equations 1, Thus the reported improvement of approximately **56%** is accurate. Additionally, **19 of 21 participants (90.5%)** showed improvement, with only two participants experiencing a small score reduction (from 100 to 90, and from 80 to 90). The highest improvement was achieved by participant AN, whose score increased from 30 to 100 (+70 points). A comparison of all pre-test and post-test scores is shown in **Figure 5**.

**Figure 4.** Workshop and project mentoring using Scratch 3.0

The significant increase in test scores indicates the effectiveness of Scratch-based Project-Based Learning (PjBL) in fostering foundational computational thinking and digital literacy. These findings align with Resnick et al. (2009), who noted that Scratch encourages creative experimentation and iterative problem-solving—core elements of computational thinking. Similar improvements were also reported by Qodir & Efendi (2024), where Scratch facilitated better understanding of programming logic among junior high school students.

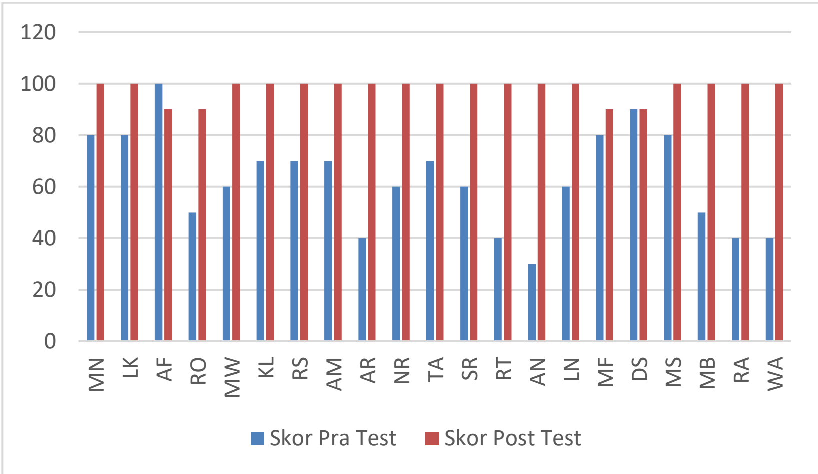


**Figure 5.** Comparison of pre-test and post-test scores of 21 participants

Furthermore, the learning gains observed in students with initially low to moderate scores (30–70) support findings from Nurdalilah et al. (2025), which emphasize that early exposure to visual programming can significantly boost confidence and conceptual understanding among beginners. The group-based project mentoring also aligns with PjBL principles, enabling students to collaboratively develop solutions and apply computational concepts in contextually meaningful tasks. Overall, the results suggest that combining Scratch with a PjBL framework offers an inclusive and accessible model for digital literacy development, particularly for underprivileged students who rarely gain structured exposure to technology-driven learning activities. This strengthens the relevance of community-based digital education programs as complementary interventions to formal schooling.

Despite the positive outcomes, several limitations should be acknowledged. First, the number of participants was relatively small (n = 21), which may limit the generalizability of the findings. Second, the program was conducted within a short time frame, restricting the opportunity to observe long-term skill development or retention. Third, the absence of a control group prevents direct comparison with other instructional approaches or traditional classroom methods. These limitations highlight the need for more comprehensive and systematic studies to fully evaluate the effectiveness of Scratch-based interventions.

Future programs would benefit from integrating Scratch modules into regular school curricula so that computational thinking is reinforced consistently over time rather than through short-term workshops. Longitudinal evaluations should also be conducted to measure retention, transfer of skills, and changes in student motivation. Expanding the program to multiple schools, including a control group, and involving teachers in co-implementation would provide stronger evidence of instructional impact and scalability. Broadly, these recommendations can help strengthen efforts to reduce digital skill gaps and support inclusive technology education for diverse student populations.

## 4. CONCLUSION

This community service program aimed to enhance students' digital literacy and computational thinking skills through a Scratch-based Project-Based Learning (PjBL) approach. The results clearly support this objective: students' average scores increased substantially from 62.86 in the pre-test to 98.10 in the post-test, indicating a 56% improvement. The combination of hands-on visual programming activities, structured mentoring, and project-oriented tasks effectively strengthened students' ability to understand sequencing, logic, and basic algorithmic thinking, while also fostering creativity and engagement. These outcomes demonstrate that Scratch-based PjBL can serve as an accessible and impactful model for empowering underprivileged learners with essential 21st-century digital competencies.

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## CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article. The community service activities and the preparation of this manuscript were conducted independently, without any financial, commercial, or personal relationships that could influence the outcomes of this work. All stages of the program were carried out under the academic and ethical oversight of the participating institutions, ensuring that the procedures, reporting, and dissemination complied with institutional guidelines and standards.

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