

Strengthening SDIT Students Computational Thinking through Computational Thinking Activities - Unplugged Binary Digits and Product Codes

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Abstract

Computational thinking (CT) is a key 21st-century competency that needs to be developed from elementary school level because it is related to problem-solving skills, logical thinking, and creativity in the context of digital technology. Teachers play a central role in integrating CT into learning, but many elementary school teachers are unfamiliar with the concept of CT or its learning strategies. One effective approach that is appropriate for the characteristics of elementary school students is the CT-Unplugged activity, a computer-free activity that represents core computer science concepts in a concrete and enjoyable way. This community service activity aims to improve the understanding and skills of SDIT Mafatih teachers in implementing two CT-Unplugged modules: how binary digits work and checking product code digits (check digits), as a means of strengthening students' CT. The training was conducted at SDIT Mafatih involving 23 teachers through material presentations, demonstrations, activity simulations, and lesson plan design. Evaluation used pre- and post-tests of CT knowledge as well as questionnaires on perceptions and confidence in teaching CT. The results showed an increase in teachers' knowledge scores regarding CT concepts and binary digit/product code materials, as well as increased confidence in adapting CT-Unplugged activities into classroom learning. Teachers also produced several learning activity designs that integrated the module with elementary school lesson themes. This activity demonstrated that structured CT-Unplugged-based training is effective in building CT literacy and pedagogical capacity in elementary school teachers.

Keywords: Computational thinking, CS Unplugged, Elementary school, Community service.

1. INTRODUCTION

Computational thinking (CT) was introduced by Wing as a way of thinking in formulating problems and solutions so that they can be effectively executed by computational agents, both human and machine [1]. Various studies confirm that CT is not only relevant for aspiring computer scientists but is a generic 21st-century competency encompassing decomposition, pattern recognition, abstraction, and algorithm design [2], [3]. The integration of CT at the K-12 level is considered crucial to prepare students for an increasingly digitalized society, while also supporting the development of higher-order thinking skills such as problem-solving and critical thinking [2], [4], [5].

In the context of elementary education, CT needs to be introduced in a manner that aligns with the characteristics of students' cognitive development. Several studies have shown that CT can be developed through various approaches, such as games, unplugged activities, project-based problem-solving, and block-based visual programming [3], [6]. Unplugged activities are considered attractive because they allow students to understand core computer science concepts without relying on digital devices, making them highly relevant for schools with limited technological infrastructure [3], [6], [7]. Empirical studies report that CT-Unplugged activities can improve elementary school students' CT skills while maintaining motivation and learning engagement [6]-[8].

The success of CT integration in elementary schools is strongly influenced by teachers' understanding, attitudes, and skills. Several studies indicate that many teachers are unfamiliar with the term CT, do not clearly understand its components, and lack examples of learning

activities that can be directly implemented in the classroom [4], [5], [9]. Teachers need support in the form of structured, contextualized, and practice-oriented professional development programs so that they not only understand CT concepts theoretically but also feel confident integrating them into the subjects they teach [5], [9], [10]. At the same time, teachers need to be exposed to examples of activities that are simple, resource-efficient, yet meaningful for students' CT development.

CS Unplugged is an international resource that provides a collection of research-based unplugged activities for teaching computer science concepts such as binary numbers, data representation, coding, and error detection [7], [11]. Among the relevant activities for elementary school students are "How Binary Digits Work," which introduces the concept of bits and the binary number system through cards with values 1, 2, 4, and 8, and "Product Code Check Digits," which introduces the idea of a check digit in a barcode as an illustration of error detection techniques [11], [12]. Both activities naturally foster algorithmic thinking, decomposition, and pattern recognition. However, the use of such activities in elementary school learning in Indonesia, particularly in Islamic-based schools such as the Integrated Islamic Elementary School (SDIT), remains relatively limited.

Initial discussions with SDIT Mafatih indicated that the concept of CT, the binary number system, or the idea of check digits had never been explicitly taught to students. Teachers generally lacked reference modules or concrete activities that could be used to instill CT in students, even though the school had encouraged the strengthening of science and technology literacy. Based on these conditions, this community service activity was designed to improve the understanding and skills of SDIT Mafatih teachers in implementing two CT-Unplugged modules: binary digits and product codes, as a means of strengthening students' CT. Specifically, this activity aims to introduce the CT concept to teachers, facilitate direct experience in carrying out CT-Unplugged activities from the students' perspective, and assist teachers in developing learning designs that integrate the module into the context of the subjects at SDIT Mafatih.

2. METHOD

This community service activity used a one-group pre-test-post-test training design to assess changes in teacher knowledge before and after the intervention. The training was held at SDIT Mafatih, Bekasi, on December 6, 2025, and was attended by 18 teachers, consisting of class teachers and subject teachers. Participants were selected by the school based on their availability and involvement in learning development. The series of activities included four main stages: an introduction to the CT and CT-Unplugged concepts, a binary digit module simulation, a product code module simulation, and lesson plan design. In the introductory stage, the facilitator explained the basic concepts of CT and its components and provided a brief overview of various CT activities in elementary schools, emphasizing the advantages of the unplugged approach.

The next stage was a simulation of the "binary digit" module, adapted from CS Unplugged materials and previously developed training modules. Teachers played the role of students and participated in an activity using binary cards with the values 1, 2, 4, and 8 to represent small decimal numbers. Then, they discussed decimal-binary conversion algorithms and opportunities for integrating them into mathematics or thematic lessons. Following this, a product code module simulation was conducted, introducing teachers to the concept of check digits in barcodes and practicing calculating check digits using worksheets. Discussions focused on how this activity could be connected to topics related to buying and selling, numeracy literacy, and students' daily lives. In the final session, participants were divided into small groups to develop lesson plans integrating one or both CT-Unplugged modules into relevant themes at SDIT Mafatih. Each group presented their plans for feedback.

The evaluation instruments used consisted of a CT knowledge test and a perception questionnaire. The knowledge test consisted of multiple-choice questions and short essays covering the definition of CT, CT components, the concept of binary numbers, and the steps for calculating check digits. The tests were administered as a pre-test before the training began and

as a post-test after all training sessions were completed. The perception questionnaire used a four-point Likert scale to assess teachers' perceptions of the training's usefulness, level of understanding of the material, and their confidence in implementing CT-Unplugged activities in the classroom. The data were analyzed descriptively by comparing the average pre-test and post-test scores, and summarizing the tendencies of questionnaire responses to describe changes in teachers' knowledge and attitudes after participating in the training.

3. RESULT AND DISCUSSION

Based on the results of processing the 2025 Abdimas Pre-Test sheet, it was recorded that 23 teachers filled out the pre-test instrument with scores ranging from 14 to 26 out of a maximum score of 26. The average pre-test score was 20.8 or around 79.9% of the maximum score, with a quartile distribution showing that 25% of participants were below a score of 19 and another 25% were above a score of 22. If categorized into three ability ranges, 12 teachers (52.2%) were in the 60–79% range, 10 teachers (43.5%) were in the $\geq 80\%$ category, and only 1 teacher (4.3%) scored below 60%. These results indicate that in general, SDIT Mafatih teachers have a fairly good initial knowledge base related to the material and basic concepts being tested, but there is still room for strengthening, especially for participants in the medium and low categories. These findings align with previous studies showing that teachers need ongoing professional development to strengthen their theoretical and applied understanding of computational thinking and related computer science topics [6]–[8].

Training participant feedback, collected through the Training Participant Feedback form, was completed by 12 respondents and provided a positive overview of the activity's implementation. Regarding material relevance, 66.7% of respondents rated the material as very relevant, and 33.3% rated it relevant to their needs. Regarding material completeness, 41.7% stated it was very complete, 50.0% considered it complete, and only 8.3% considered it quite complete. The presenters' ability to answer participants' questions was also very good, with 66.7% of respondents rating it as very good and 33.3% rating it as good. The workshop's timing and schedule were rated as very appropriate by 50.0%, appropriate by 41.7%, and quite appropriate by 8.3% of respondents. Regarding readiness to implement the material, all respondents were in the positive category: 25.0% felt very prepared, 33.3% ready, and 41.7% somewhat prepared to try adapting the training materials into their lessons.

Participants' open-ended responses provided additional constructive information. Some teachers hoped for additional icebreakers and a slightly more flexible time allocation to prevent discussions and practice from feeling rushed. There were also suggestions for increasing the practical portion, for example, by gradually creating small projects. They also suggested further materials such as digital learning media, personal data security, fun coding for children, educational games and animations, and the use of AI in learning. This feedback confirmed that the training was not only perceived as beneficial but also generated a need and interest for further training, aligning with literature emphasizing the importance of ongoing support and communities of practice for teachers integrating CT and educational technology in the classroom.

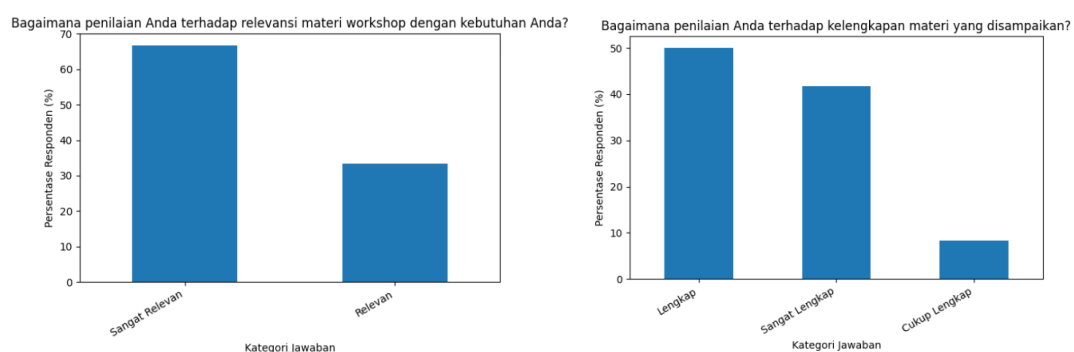


Figure 1. Training participant response

Perception questionnaire data also showed a positive response to the training. The majority of teachers stated that the training materials were relevant to the learning needs at SDIT Mafatih and provided new ideas on how to instill logical thinking and problem-solving in students without always having to use computers. Teachers felt the “binary digit” activity was easy to adapt to explain number patterns and reinforce place value concepts, while the “product code” activity was considered interesting to connect with the theme of buying and selling and simple numeracy literacy in students’ daily lives. In addition, many teachers reported increased confidence in trying to implement CT-Unplugged activities in the classroom, although some still stated that they needed more detailed examples of lesson plans and opportunities for guidance during the initial implementation. This is consistent with previous findings that ongoing support and concrete examples of practice are crucial for the success of CT integration in elementary schools [4], [5], [9], [10].



Figure 2. Delivery of material by resource persons

Another important product of this activity was the CT-Unplugged-based learning designs developed by teachers during the design session. Several groups produced activity designs that integrated the “binary digit” module into the theme of electrical energy or number material in mathematics, with students acting as “binary lights” that turn on or off according to the number value. Another group developed a learning scenario themed “a small shop in the classroom” that utilized product packaging and barcodes as media to practice check digit calculations while developing students’ numeracy and collaboration skills. These designs demonstrated that teachers were able to contextualize the CT-Unplugged module into the SDIT Mafatih thematic curriculum and add elements of values and character aligned with the school’s vision. Overall, the training results indicated that the CT-Unplugged approach not only enriched teachers’ insights into CT but also opened up creative space in designing meaningful learning experiences for students.



Figure 3. Group photo with the teachers participating in the training

4. CONCLUSION

A community service activity in the form of CT-Unplugged training on "binary digits" and "product codes" for teachers at Mafatih Islamic Elementary School (SDIT) successfully improved teachers' understanding and skills related to computational thinking, as well as binary and check digit representations. Improved post-test scores compared to pre-tests demonstrated that the training, which combined conceptual introductions, student-led activity simulations, and pedagogical reflection sessions, was effective in building CT literacy among elementary school teachers. Questionnaire results revealed that teachers found the CT-Unplugged activities relevant, enjoyable, and relatively easy to adapt to elementary school learning themes, while also increasing their confidence in integrating CT into their daily teaching practices. The resulting lesson plans reflected teachers' ability to contextualize the "binary digits" and "product codes" modules within the Mafatih Islamic Elementary School curriculum by integrating numeracy, science, and Islamic values.

However, further support is needed in the form of developing more detailed lesson plans and classroom implementation support to ensure sustainable CT-Unplugged integration. Therefore, this activity recommends a follow-up program in the form of implementation assistance, development of a CT practitioner community within the SDIT Mafatih teacher community, and expansion of the CT-Unplugged module to other topics relevant to the elementary school curriculum. With these ongoing efforts, it is hoped that strengthening computational thinking at the elementary school level will not stop at the teacher training level but will truly impact the quality of students' learning experiences in the classroom.

REFERENCES

- [1] J. M. Wing, "Computational thinking," *Communications of the ACM*, vol. 49, no. 3, pp. 33–35, 2006.
- [2] S. Grover and R. Pea, "Computational thinking in K–12: A review of the state of the field," *Educational Researcher*, vol. 42, no. 1, pp. 38–43, 2013.
- [3] J. del Olmo-Muñoz, R. Cózar-Gutiérrez, and J. A. González-Calero, "Computational thinking through unplugged activities in early years of primary education," *Computers & Education*, vol. 150, p. 103832, 2020.
- [4] S. F. Erümit, "Collaboration of unplugged and plugged activities for primary school students: Developing computational thinking skills with programming," *International Journal of Computer Science Education in Schools*, vol. 6, no. 3, pp. 1–15, 2024.
- [5] N. D. Septiyanti, J.-L. Shih, and M. Zakariyah, "Fostering computational thinking through unplugged and robotic collaborative game-based learning on primary school students," *American Journal of Educational Research*, vol. 8, no. 11, pp. 866–872, 2020.
- [6] N. Afifah, S. Ulfa, P. Setyosari, and Y. Soepriyanto, "Unplugged activity to improve students' computational thinking skills second grade elementary school," *JKTP: Jurnal Kajian Teknologi Pendidikan*, vol. 8, no. 4, pp. 1–12, 2025.
- [7] P. Oktaviani, A. S. Puspitawati, and N. Hufad, "Unplugged coding to develop computational and problem-solving skills in early childhood," *Jurnal Pendidikan Usia Dini (JPUD)*, vol. 19, no. 1, pp. 1–15, 2025.
- [8] B. Kasiono and N. H. Putri, "Unplugged coding, computational thinking, elementary students, and inclusive learning: A systematic literature review," *Pedagogy: Journal of Education*, vol. 8, no. 2, pp. 1–18, 2025.
- [9] D. I. H. Putri et al., "Computational thinking and coding for kids training for elementary school teachers," *REKA ELKOMIKA: Jurnal Pengabdian kepada Masyarakat*, vol. 3, no. 3, pp. 142–151, 2022.
- [10] S. Çimşir and E. Kıyıcı, "Perceptions of primary school teachers on computational thinking skills," *Informatics in Education*, vol. 22, no. 2, pp. 191–211, 2023.

- [11] X. P. Voon, S. L. Wong, L. H. Wong, M. N. M. Khambari, and S. I. S. Syed-Abdullah, "Developing pre-service teachers' computational thinking through experiential learning: Hybridisation of plugged and unplugged approaches," *Research and Practice in Technology Enhanced Learning*, vol. 18, p. 006, 2023.
- [12] K. Anggraini, D. Setyaningrum, and A. F. Pradipta, "Pelatihan computational thinking secara unplugged kepada guru PAUD PPT Mutiara Bunda Ondomohen," *JABB: Jurnal Aplikasi Bisnis dan Bisnis*, vol. 7, no. 2, pp. 1-8, 2025.