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UNPLUGGED ACTIVITY TO IMPROVE STUDENTS' COMPUTATIONAL THINKING SKILLS SECOND GRADE ELEMENTARY SCHOOL

Nurul Afifah, Saida Ulfa, Punaji Setyosari, Yerry Soepriyanto
Teknologi Pendidikan, Universitas Negeri Malang, Malang, Indonesia
fifadaipa@gmail.com

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Abstrak
Penelitian ini bertujuan mendeskripsikan dan menganalisis penerapan unplugged activity terhadap peningkatan keterampilan computational thinking siswa kelas dua sekolah dasar di lokasi sesungguhnya dengan keterbatasan akses. Hal ini perlu dilakukan karena kemampuan ini diperlukan di masa yang akan datang, selain itu di Indonesia masih banyak daerah yang belum mendukung sepenuhnya teknologi informasi dan komunikasi. Desain penelitian yang digunakan adalah pra-eksperimen dengan tipe one-group pretest-posttest. Instrumen penelitian berupa tes keterampilan computational thinking meliputi indikator dekomposisi, pengenalan pola, abstraksi, dan algoritma. Hasil penelitian menunjukkan bahwa ada perbedaan signifikan antara skor pretest dan posttest, yang berarti bahwa *unplugged activity* mampu meningkatkan kemampuan computational thinking siswa. Meskipun secara skor gain sedang dan tafsiran cukup efektif, aktifitas ini mampu memotivasi, dan melibatkan siswa dalam pembelajarannya sehingga kelas tidak hanya aktif tetapi menjadi interaktif.

Kata Kunci: Aktifitas non komputer; SD; kelas dua; berpikir komputasi

Abstract
This study aims to describe and analyze the application of unplugged activity to improve the computational thinking skills of second-grade elementary school students in a real-world setting with limited access. This is necessary because these skills will be needed in the future, and in Indonesia, many areas still do not fully support information and communication technology. The research design used was a pre-experimental one-group pretest-posttest. The research instrument was a computational thinking skills test covering indicators of decomposition, pattern recognition, abstraction, and algorithms. The results showed a significant difference between the pretest and posttest scores, indicating that unplugged activity was able to improve students' computational thinking skills. Although the gain score was moderate and interpreted as quite effective, this activity was able to motivate and engage students in their learning, making the class not only active but also interactive.

Keywords*: Unplugged Activity; primary school; second grade; computational thinking*

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INTRODUCTION

The digital era and the Industrial Revolution 4.0 demand many things to navigate. This transformation is marked by changes in all aspects of industrial production, along with the accompanying digital and internet technologies. Some key characteristics are high connectivity between devices, machines, and humans, the use of artificial intelligence, the implementation of intelligent robots, the integration of the physical and digital worlds, and so on ("Facing the Era of Industrial Revolution 4.0: The Importance of Competency Enhancement," 2023).

Facing this era and revolution requires competencies to navigate it. Some of these competencies include technological skills, programming and coding skills, creativity and innovation, digital marketing skills, and problem-solving skills. These competencies can be developed through learning, one of which is Computational Thinking skills. Computational thinking is a fundamental skill that is essential for students to possess, as important as other basic skills such as reading, writing, and arithmetic (Mohaghegh & McCauley, 2016).

Computational thinking (CT) skills are an approach to problem solving, system design, and understanding human behavior that draws on fundamental computing concepts (Wing, 2006). These skills are globally recognized and trusted as essential skills for the 21st century. These skills should be mastered by everyone, not just computer scientists. Computational thinking involves problem solving, system design, and understanding human behavior, drawing on fundamental concepts in computer science. However, these skills are not just about programming, but also about solving complex, logical, and systematic problems, including decomposition, pattern recognition, abstraction, and algorithms. Therefore, CT should be developed early, even in elementary school, as the foundation for logic and problem-solving is being laid. CT will help students think in a structured, logical, and creative way, which will be beneficial for learning other subjects and for the future. This was also conveyed in Bebras Indonesia, which introduced Computational Thinking (CT) from elementary school (Bebras Indonesia Challenge 2017: Computational Thinking Learning Materials for Elementary Schools, 2017) and is supported by an academic paper issued by the Ministry of Education and Culture (Kemendikbud, DASMEN) (Academic Paper: Coding and Artificial Intelligence Learning, 2025).

Challenges faced by schools in equipping students with CT include limited access to hardware (computers/laptops) and adequate internet connections, or even a lack of teachers with a computer science background. These limitations hinder the introduction of CT concepts through plugged-in methods, or using devices. The solution is to use unplugged activity (UA) methods, or activities without computers, that are innovative and inclusive.

Basic computing concepts such as algorithms, sequencing, looping, debugging, and decomposition are typically taught through the use of computers, but unplugged activities teach these concepts without using computers. Bell, Alexander, Freeman, & Grimley (2009) provide several examples of how unplugged activities teach CT through games, puzzles, paper, cards, and physical activities without the need for electronic devices or storytelling methods (Ningrum, Setyosari, & Soepriyanto, 2022).

Several studies have demonstrated that UA can be applied to all levels of education in CT skills. This activity was compared with Plugged Activities for kindergarten children aged 5-6. The results found no differences in CT skills, motivation, and cooperative behavior. The difference lies in representation (Lin, Liao, Weng, & Dong, 2024). Early childhood children also successfully improved CT through UA, although only in three skills: pattern recognition, sequencing, and algorithm design (Saxena, Lo, Hew, & Wong, 2020). This comparison was also conducted at the elementary school level, finding that UA had a positive impact on teaching CT and programming fundamentals, although not on CT skills (Polat & Yilmaz, 2022). A study of sixth-grade elementary school students found that UA significantly improved student performance in CT skills and student engagement (Li et al., 2023). A study conducted in junior high schools found that UA improved CT, although there was no difference in problem-solving ability (Tonbuloğlu & Tonbuloğlu, 2019).

Based on the previously described research, UA for CT skills is generally effective at all levels of education. Although there has been no specific research in second-grade elementary school, it is suspected that UA is particularly suitable for second-grade elementary school students because it is concrete, interactive, and game-based, promoting teamwork and gross/fine motor skills. Research by Setiawan, Widyasari, & Aprinastuti (2023) revealed that UA at the same educational level can increase student activity.

Unplugged activity is a promising method for computational thinking skills, but there is still little research specifically testing this method to improve CT in second-grade elementary school students. This level plays a crucial role in strengthening the foundations of thinking. Furthermore, no research has been conducted in a real-world location with limited access, such as around Mount Bromo. Therefore, this study aims to investigate and empirically prove the influence/effectiveness of Unplugged Activity in improving Computational Thinking (CT) skills in second-grade elementary school students. This can provide practical recommendations for teachers in integrating CT in schools with limited technology.

METHOD

This study used a quantitative approach with a one-group pretest-posttest pre-experimental design. The study was conducted at the UPT SDN Kandangan I Tosari, Pasuruan Regency during May–June 2022. The research subjects consisted of 23 second-grade students. Class meetings were held three times with daily life activities material involving writing, visuals and implementing activities including sequencing, creating algorithms, visual presentations, game activities, puzzles, and finding solutions to daily problems.

The research instrument was a computational thinking ability test covering four main indicators: decomposition, pattern recognition, abstraction, and algorithms. The instrument's validity was tested by an expert using a validation questionnaire with Likert-scale responses. If the instrument is valid, it is suitable for use in data collection.

The data collected were pre-test and post-test scores, each with the same test questions. The initial test was a basic assumption test, namely, the normality of the data. If the normality test yields normally distributed data, further testing can be conducted. Hypothesis testing can then be conducted to prove a significant difference between before and after treatment. Data were analyzed using SPSS version 25.

Gain score calculations are necessary to categorize the success of the improvement, both in terms of effectiveness and level (Hake, 1998). Based on the interpretation of effectiveness, there are four categories, namely ineffective (<40%), less effective (40-55%), quite effective (55-75%) and effective (>76%), while based on the level, there are three categories, namely low (<0.3), medium (0.3-0.7) and high (g>0.7).

RESULT

The results of the descriptive statistical analysis are presented in Table 1. For the pre-test, the average score was 54.78 with a standard deviation of 17.286 and a variance of 298.814. The lowest score was 20 and the highest was 80, so the range of scores for pre-CT learning treatment was 60. The average score after treatment was 80 with a standard deviation of 8.528 and a variance of 72.727. Students' highest score was 100 and their lowest was 60, so the data range was 40. Their computational thinking skills were seen to have higher scores after students learned.

Table 1. Descriptive Analysis Result

	Mean	SD	Variance	Minimum	Maximum	Range	N
Pre test	54.78	17.286	298.814	20	80	60	23
Post test	80.00	8.528	72.727	60	100	40	23

The basic assumption test was conducted, namely the data normality test, referring to the results of the Shapiro-Wilk analysis due to the small sample size. Table 2 presents the analysis results, which show that the significance value (0.352) > 0.05. This result indicates that H0 is accepted, indicating that the score data is normally distributed.

Table 2. Normality Data Test Result

	Statistic	df	Sig.
Score Test	.954	23	.352

After deciding that the data is normally distributed, the next step is a paired t-test. The results of the analysis test are presented in Table 3, which consists of the average difference, standard deviation, t-score, degrees of freedom, and its significance. The average difference score is 25.217 with a standard deviation of 11.627 and a significance value of 0.000. With a sig = 0.000 based on the proposed hypothesis that H0 fails to be accepted if sig <0.05, this can be interpreted as indicating a significant difference between before and after being taught computational thinking skills through UA. However, some students were identified as still not improving, and some even had a decrease in score.

Table 3. Pair Sample T-test Result

	Mean	SD	t	df	Sig. (2-tailed)
Post_Test-Pre_Test	25.217	11.627	10.402	22	.000

To determine the extent of the improvement, an N-Gain (Gain Score) test was conducted. The N-Gain test yielded a score of 0.56, which is in the moderate category. For the effectiveness category, the N-Gain score x 100% = 56%, which falls into the Hake-estimated category of moderately effective.

The findings of student learning experiences were based on observations during the lesson. Several positive aspects emerged and were well identified, including student responses indicating a desire to learn again with the UA. Student engagement in learning was high, as indicated by everyone trying to solve problems and the class being lively. The class became active, even tending to be interactive. Student motivation was also high in solving the problems given.

DISCUSSION

The inclusion of programming in the elementary school curriculum has been actively discussed in many countries worldwide (Artym, Carbonaro, & Boechler, 2017; Kong, 2019; Mukasheva & Zhilbayev, 2016; Yadav, Mayfield, Zhou, Hambrusch, & Korb, 2014). Programming has been included in the elementary school curriculum in several countries (National Curriculum for Basic Schools–Riigi Teataja, 2014; The National Curriculum in England, 2014). However, the possibility of including the subject in Indonesia is not ruled out. Therefore, all elementary school stakeholders must be prepared to implement it under any circumstances. Therefore, its implementation is highly dependent on regional conditions in Indonesia. Limited access is a real condition and is often found throughout Indonesia.

The findings of this study provide broader opportunities and possibilities due to the more concrete location of the study, located in a mountainous area on the island of Java, which has limited access to both communication signals and technology. This corroborates the findings of previous studies.

The second-grade elementary school students in this study demonstrated the success of implementing UA in improving CT skills. This aligns with findings from a literature review conducted by Chen, Yang, Metwally, Lavonen, & Wang (2023), which found that UA is promoted as a learning strategy capable of improving CT skills at various educational levels. A similar study, conducted in a remote village in Sarawak, Malaysia, emphasized UA rather than the subject itself. The findings indicated that CT skills can be achieved through arts and culture subjects (Anuar, Mohamad, & Minoi, 2020). As stated by Chan et al. (2021), computational thinking is not limited to computer science but is a set of skills applicable across various subjects.

The improvement in CT skills found in this study corroborates previous research findings. Although previous findings did not reveal the score gain, this study provides insight into the extent of the score gain, despite the small number of students. Research (Liu & Hu, 2025) in rural schools in China revealed significant improvements in computational thinking skills and resilience through technology-free activities. Resilience is considered a key factor in improving computational thinking skills.

This study did not examine the impact of UA on computational thinking skills, but numerous studies have done so. Experimental research by Brackmann et al. (2017) revealed that students in the experimental group who received UA improved their computational thinking skills compared to the control group. This demonstrates that the UA approach is effective in developing these skills. These findings also support the conclusion of Città et al. (2019), namely the relationship between sensorimotor factors and higher-order cognitive processes, which demonstrates the impact of the UA approach on the acquisition of computational thinking skills. The implementation of UA in developing countries like Colombia revealed that learning activities positively impact computational thinking knowledge and skills, even after controlling for school context and gender (Vieira, Gómez, Gómez, Canu, & Duque, 2023).

To improve outcomes, research by Del Olmo-Muñoz, Cózar-Gutiérrez, & González-Calero (2020) suggests that it is more appropriate to work on CT in the early years of primary education through a mixed approach that combines unplugged and plugged-in activities rather than solely plugged-in activities. This suggestion is reinforced by Tsarava et al. (2017) and Tsarava, Moeller, & Ninaus (2018), who noted that this combination can also increase motivation.

Research findings through observations identified motivated learners in learning activities using the UA approach. Research by Jiang & Wong (2019) revealed that students exhibited motivation ranging from moderate to high. Furthermore, compared to the unplugged approach, students achieved higher perceived competence from the plugged approach. This indicates that UA can increase learner motivation and competence.

Interest in learning through UA was expressed by students who responded that they wanted to repeat the lesson. Clearly, UA is an engaging activity for students. High levels of engagement were also revealed in research (Leifheit, Jabs, Ninaus, Moeller, & Ostermann, 2018), which found that learners rated the learning experience positively and were more interested in the computer topic itself. This engagement may stem from the books included in the learning, as revealed in the research findings of Ballard & Haroldson (2022). Twenty-seven books offered non-programming, unplugged approaches for each age range, with CT elements included.

During the learning process with UA, student engagement was high, resulting in a more conducive classroom environment. This high level of student engagement further develops students' learning. This was also reported in a study of 13 teachers who taught CT in New Zealand and provided feedback on engagement across a wide range of topics (Duncan, Bell, & Atlas, 2017). This finding is a key concept and a growing issue in the elementary school context.

In a study by Dağ, Şumuer, & Durdu (2023), it was revealed that through UA, not only CT skills but also collaborative and communication skills were significantly improved. This finding can be interpreted as meaning that UA alone can reach several skills that are significantly correlated. Furthermore, other findings from integrating CT skills into mathematics teaching and learning promote critical thinking, creativity, collaboration, and effective communication among students (Mohmad & Maat, 2024). All of these skills are needed as 21st-century skills that must be provided to students.

The scores obtained by some students indicate a lack of improvement. This requires attention from researchers and teachers to identify the causes. Several possible causes include the content presented, the delivery strategy, and the lack of experience of the students or teachers in teaching it. While the material presented relates to students' daily lives, the questions test CT skills, which are indicators of their ability to think like a machine. The learner's age also determines achievement, as this age group is not yet capable of abstract thinking. This ability develops at age 11 (Babakr, Mohamedamin, & Kakamad, 2019), based on Piaget's 1962 theory of cognitive development (Piaget, 2013). Teachers' experience in implementing UA also contributes to the success of all their students. Hsu, Chang, & Hung (2018) highlighted these factors, stating that the content, methods, and approaches used in teaching CT should adapt to the learner's cognitive level. Daily activities such as making breakfast and preparing for school can be used to illustrate and teach algorithms, but what is being studied is machine learning. Although some literature suggests that UA can be used to understand algorithms through daily activities as sequential steps, it should not be an agent in itself. Combining unplugged and plugged activities would be more meaningful, as stated by Caeli & Yadav (2020). The findings of Fiş Erümit's (2024) research with a single-group quasi-experimental design support this statement.

CONCLUSION

This study aims to describe and analyze UA to improve CT skills of second-grade elementary school students at a real location on Mount Bromo. CT skills learning with the UA approach has been conducted in a real location with limited access criteria. The findings are that CT skills can be improved with UA proven, although the gain score category is quite effective and at a moderate level. Some limitations of this study include the number of students is too small, so it cannot be generalized. Further research needs to be conducted on a large scale with a larger sample in real locations with limited access. The implication of this study's findings is that UA may be implemented in second-grade elementary schools around the mountains to equip students from the beginning with CT skills.

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