

Map-Based Unplugged Coding in Elementary Social Studies: A Pre-Experimental Study on Third-Grade Students' Computational Thinking Skills

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ABSTRACT

This study was motivated by the importance of computational thinking (CT) skills in elementary school Social Studies learning, particularly for helping students decompose travel routes and understand map concepts. It aimed to examine the difference in third-grade students' CT skills before and after learning that integrates unplugged coding with map media in Social Studies. A quantitative pre-experimental approach with a one-group pretest-posttest design was employed, involving 23 third-grade students (from an initial cohort of 26) in Class III-A at SDN 02 Sindangkasih. Data were collected using a five-item CT test covering decomposition, pattern recognition, abstraction, and algorithmic thinking, and were analyzed using the Shapiro-Wilk normality test, a paired-sample t-test, and the Normalized Gain (N-Gain) index. The mean CT score increased from 45.87 (pretest) to 74.56 (posttest). The paired-sample t-test indicated a statistically significant difference, $t(22) = -6.74$, $p < .001$, with a large effect size ($d \approx 1.41$), leading to the rejection of H_0 and the acceptance of H_a . The mean N-Gain was 0.54, falling into the medium category. These findings indicate that map-based unplugged coding was associated with a significant improvement in third-grade students' computational thinking skills, although the absence of a control group means this improvement cannot be attributed to the intervention alone.

Keywords: Computational Thinking; Unplugged Coding; Social Studies; Map; Elementary School

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INTRODUCTION

Accelerating technological and scientific developments in the 21st century have driven transformative shifts across diverse sectors, including the field of education. The era of the Industrial Revolution 4.0 that transforms towards Society 5.0 demands the education system to produce human resources who not only master knowledge, but also have various skills of the 21st century (Budiarti et al., 2022). One of the competencies that is receiving increasing attention in the world of education is Computational Thinking.

The concept of Computational Thinking gained widespread recognition through Jeannette Wing in 2006, who framed it as a foundational problem-solving approach, system design methodology, and framework for understanding human behavior grounded in core computer science principles (Sitepu & Yahfizham, 2024). As it has evolved, Computational Thinking is no longer understood merely as a part of computer science, but as a general cognitive approach to problem-solving that can be applied across various disciplines (Trisnawati et al., 2025). According to Ansori, (2020), Computational Thinking represents a cognitive problem-solving framework that applies core computer science principles, specifically decomposition, pattern recognition, abstraction, and algorithms design to deconstruct and resolve complex problems. These four components demonstrate that Computational Thinking focuses on a systematic and logical thought process in problem-solving.

Computational Thinking has the potential to be integrated into various school subjects, including Social Studies. Conceptually, elementary Social Studies education spans core domains including human environments interactions; temporal continuity, sustainability, and change; social and cultural structures; as well as economic activities and societal well-being (Tasrif in Akmal, 2025). This scope indicates that social studies learning is not only oriented toward mastering facts but also toward understanding interpersonal relationships, the dynamics of space and time, and social activities in daily life.

Mastery of social studies in elementary school should be a provision for students to understand and solve various social problems in their surrounding environment. However, in practice, Social Studies is still often perceived as a subject that relies on rote memorization, making it less effective at encouraging students' active engagement as well as the cultivation of higher-order thinking skills (L. Sari et al., 2022). This situation has hindered the growth of students' systematic reasoning and problem-solving capacities in understanding social phenomena.

This issue is evident in the teaching of school campus map material. In this unit, students are not only required to understand compass directions and symbols but also to be able to explain travel routes in a coherent and logical manner. However, in practice, students tend to mention locations randomly without paying attention to the correct sequence of the route. This situation aligns with the findings of Wenno et al. (2021), which revealed low student proficiency in determining directions on a map (51%), as well as weak ability to interpret spatial route problems, which reached only 25%. Students' inability to construct a systematic sequence of directions serves as a strong indicator that their foundation in computational thinking particularly their algorithmic thinking and decomposition skills has not yet developed optimally in social studies instruction.

Initial classroom observations in the third grade at SDN 02 Sindangkasih revealed that students continue to face substantial challenges in interpreting and comprehending spatial maps. Specifically, the majority of students struggle to determine the direction of a route, mistakenly identify the left-right positions of objects on a map, and have trouble mapping out a route from one point to another. The learning approach, which has tended to be conventional and text-centered, has made the spatial concept of maps feel abstract and meaningless to students. Therefore, a concrete approach such as physical activities is needed to help students construct a tangible understanding of space.

One promising approach to developing computational thinking at primary level is the unplugged coding approach. Unplugged coding involves learning programming concepts and computational thinking without using digital devices or computers. This approach utilizes physical activities, games, simulations, and concrete materials to introduce the concepts of algorithms, patterns, and logic in a contextual manner (Rati et al., 2024). Through this approach, students can understand the concepts of computational thinking in a simpler, more enjoyable way that is appropriate for their stage of cognitive development (see also Bell et al., 2015; Brackmann et al., 2017; del Olmo-Muñoz et al., 2020).

The characteristics of unplugged coding, which are based on concrete activities, align naturally with the development needs of primary school students, who operate predominantly within Piaget's concrete operational stage. Through their literature review, Sari et al. (2026) demonstrated that the implementation of unplugged coding is not merely a technical alternative but rather a pedagogical approach aligned with the concrete thinking stage of elementary school-aged children. In line with this (P. Chen et al., 2023) demonstrated that unplugged coding activities effective in enhancing computational thinking skills, particularly in problem-solving performance, logic, and systematic thinking through experience-based activities. Thus, the integration of unplugged coding can be viewed as a relevant learning approach to facilitate the development of computational thinking skills in primary school students.

In the context of social studies learning, the use of maps is strongly relevant to enhancing computational thinking. A map is a simple visual representation of an environment that includes symbols, directions, and relative positions. Map-based activities require students to understand the relationships between locations, recognize path patterns, simplify spatial information (abstraction), and systematically plan a route (algorithmic thinking). The integration of unplugged coding with maps can be achieved through activities such as devising algorithms for traveling from one point to another, identifying route patterns, and solving simple navigation problems. These activities directly train the components of computational thinking. Therefore, maps have the potential to be an effective tool for integrating the unplugged coding approach into social studies instruction.

Several studies have shown that integrating computational thinking into concrete-activity-based learning can improve students' problem-solving skills (Fhatrina & Tyastuti, 2026; Sartina et al., 2023; Supardi et al., 2026). Nevertheless, the majority of existing research remains centered on mathematics and science. Studies that integrate unplugged coding into social studies instruction particularly those utilizing map to develop elementary school students' computational thinking skills remain relatively limited. Consequently, this current limitation presents a distinct research gap that requires further academic inquiry

Based on this gap, the research question addressed in this study is: is there a significant difference in third-grade elementary school students' computational thinking skills before and after learning that integrates unplugged coding with map media in Social Studies? Accordingly, the following hypotheses were tested: H_0 , there is no significant difference between students' pretest and posttest computational thinking scores; H_a , there is a significant difference between students' pretest and posttest computational thinking scores.

Based on the above discussion, this study aims to analyze the impact of a computer-free programming approach supplemented with map media on elementary school students' computational thinking skills in social studies. The uniqueness of this study lies in the integration of computer-free programming activities with map media as a representation of space in social studies instruction to facilitate the development of computational thinking skills among elementary school students. While computational thinking has been widely studied through digital tools such as Scratch and Code.org, empirical evidence on developing computational thinking through unplugged, map-based activities within Social Studies instruction remains scarce; this study addresses that gap and contributes context-specific evidence on how a low-cost, device-free approach can support computational thinking development in resource-limited elementary schools (Wing, 2006; Grover & Pea, 2013; Brackmann et al., 2017; del Olmo-Muñoz et al., 2020).

METHOD

Research Design and Methods

This study employed a quantitative approach utilizing a pre-experimental research design, specifically the One-Group Pretest-Posttest Design. As noted by Lestari et al. (2025) citing Sugiyono's theoretical framework, the One-Group Pretest-Posttest Design is implemented to accurately evaluate changes resulting from an experimental treatment by directly comparing performance scores obtained prior to intervention (O_1) with those recorded post-intervention (O_2). The schematic representation of this design is illustrated in Table 1. As a pre-experimental design without a control group, this design is susceptible to threats to internal validity such as history, maturation, and testing effects (Campbell & Stanley, 1963); these threats are addressed in the Limitations section.

Table 1. One-Group Pretest-Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Note:

O_1 = Pretest before the treatment was administered

X = Treatment (Unplugged Coding approach)

O_2 = Posttest after the treatment was administered

This investigation involved two primary operational variables: the independent variable (X), representing the unplugged coding approach as the administered treatment; and the dependent variable (Y), representing the elementary students' computational thinking skills measured both before and after the implementation of the treatment.

Participants and Sampling Technique

The population for this study comprised 26 third-grade elementary school students in Class III-A at SDN 02 Sindangkasih. Total sampling was employed, wherein the entire population is utilized as the study sample (Husin et al., 2025). Consequently, all 26 students in Class III-A were selected as research participants. Throughout the implementation phase, 23 students completed all research activities, whereas three students were excluded from the final data analysis because they were absent during one of the instructional sessions, resulting in a final analyzed sample of $N = 23$ (11 girls and 12 boys, aged 8–9] years). Their pretest scores were not available for comparison; therefore, the potential influence of this attrition on the results could not be examined. This study adheres to the ethical principles of research involving children by obtaining official permission from the principal. All student identities are anonymized to ensure data confidentiality in this report.

Research Setting and Timeline

This study was conducted at SDN 02 Sindangkasih and spanned five instructional sessions with each session lasting 2×35 minutes (70 minutes). The first session was designated for administering the pretest to

measure students' baseline computational thinking skills. The second through fourth sessions involved the treatment implementation, utilizing an unplugged coding approach integrated with map media. Finally, the fifth session was devoted to the posttest administration to evaluate students' computational thinking performance following the intervention. The instructional sessions were delivered by the researcher.

Research Procedures

The research procedures were executed in three primary phases: the pretest, the treatment implementation, and the posttest. In the initial phase, a pretest was administered to evaluate students' baseline computational thinking skills. The treatment phase was conducted over three instructional sessions using an unplugged coding approach integrated with map media. The second session focused on developing decomposition and algorithmic thinking skills through map navigation activities and instruction sequencing. The third session targeted pattern recognition and abstraction through classification tasks, pattern identification, and information simplification activities using map. The fourth session served to reinforce all four computational thinking dimensions in an integrated manner. Following the completion of the intervention. A posttest was administered in the fifth session to evaluate students' computational thinking skills post-treatment.

In practice, the second session (decomposition and algorithmic thinking) engaged students in map-navigation activities in which they broke travel routes into smaller, sequential steps and arranged instructions for moving from one point to another. The third session (pattern recognition and abstraction) involved grouping buildings on a map by their characteristics and functions, identifying patterns and anomalies in navigation-code sequences, and, when redrawing a travel route, selecting only essential information while disregarding decorative elements such as trees, flowers, and clouds. The fourth session integrated all four indicators through activities that included systematically composing step-by-step travel instructions for an object or a 'robot' to follow, an intergroup debugging activity in which one group identified and corrected errors in another group's instruction sequence, and a 'secret map code' activity in which students created symbols to represent buildings and exchanged their coded instructions with other groups to test readability and accuracy.

Research Instruments, Validity, and Reliability

The research instrument used was a Computational Thinking ability test designed around four primary indicators: decomposition, pattern recognition, abstraction, and algorithmic thinking. According to Arikunto (2021), a good instrument should demonstrate validity and reliability. Accordingly, prior to use, the present instrument's content validity was examined through expert judgment involving university lecturer specializing in programming and one experienced primary school teacher, who assessed the suitability of each item for the research.

After being validated by experts, a field test was conducted on the instrument, which consisted of 10 items students outside the main research sample. Based on the empirical validity testing of the instrument using Pearson Product-Moment correlation, 8 items were found to be valid and 2 items were found to be invalid. From these 8 valid items, the researcher selected the 5 items that were considered the most representative of the four Computational Thinking indicators to be used as the final research instrument. The distribution of test items across the four Computational Thinking indicators is presented in Table 2.

Table 2. Computational Thinking Test Instrument

No	Computational Thinking Indicator	Item Number	Number of Items
1	Decomposition	1	1
2	Algorithmic Thinking	2,5	2
3	Pattern Recognition	3	1
4	Abstraction	4	1
Total			5

Upon removing non-valid items, the instrument underwent reliability testing to verify its structural consistency and measurement stability. Reliability analysis conducted via SPSS version 16.0 yielded a Cronbach's Alpha coefficient of 0.829. Since the Cronbach's Alpha value is greater than 0.60, this Computational Thinking ability test instrument is considered highly reliable for research data collection.

Data Analysis Techniques

The research data were analyzed using SPSS version 16.0. Pretest and posttest scores were first summarized using descriptive statistics. The Shapiro-Wilk test ($\alpha = .05$) was used to test the normality of the difference between pretest and posttest scores, given the sample size was below 50. As the difference scores were normally distributed, a paired-sample t-test was used to examine the mean difference between pretest and posttest scores, and Cohen's d_z (Cohen, 1988) was computed as a measure of effect size. In addition, the Normalized Gain (N-Gain) index (Hake, 1998) was computed as $(\text{posttest} - \text{pretest}) / (\text{maximum possible score} - \text{pretest})$ to determine the magnitude of improvement in students' computational thinking skills, categorized as low ($g < 0.3$), medium ($0.3 \leq g < 0.7$), or high ($g \geq 0.7$). For the item-level N-Gain, when a student had already obtained the maximum item score (20) at pretest, the N-Gain was set to 1 if the maximum score was maintained at posttest and to 0 if the score declined.

RESULTS AND DISCUSSION

This section presents the results and integrates them with the discussion, organized around the study's central finding: the change in third-grade students' computational thinking (CT) skills following the map-based unplugged coding intervention.

Table 3 summarizes the pretest and posttest descriptive statistics for students' CT scores.

Table 3. Descriptive Statistic

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	23	5.00	85.00	45.8696	20.37446
Posttest	23	35.00	100.00	74.5652	20.66580
Valid N (listwise)	23				

As shown in Table 3, students' pretest scores were relatively low ($M = 45.87$, $SD = 20.37$), reflecting considerable variation in initial ability, including some students who scored as low as 5. Following the intervention, the mean posttest score rose to 74.56 ($SD = 20.67$); the persistently large standard deviation indicates that gains were not uniform across students, and the posttest maximum of 100 alongside a minimum of 35 suggests that some lower-performing students still improved only modestly (*see the N-Gain distribution reported below*).

Prior to hypothesis testing, a Shapiro-Wilk normality test was conducted (Sianturi, 2025), and the results (Table 4) indicated that the pretest and posttest score, as well as the difference scores ($p = .120$), satisfied the normality assumption ($p > .05$), meeting the prerequisite for the paired-sample t-test analysis.

Table 4. Computational Thinking Normality Test

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest	.982	23	.939
Posttest	.930	23	.108
Difference (Posttest – Pretest)	.932	23	.120

A paired-sample t-test was conducted to examine whether the difference between pretest and posttest CT scores was statistically significant; results are presented in Table 5.

Table 5. Paired Sample *t*-Test

	t	df	Sig. (2-tailed)
Pretest - Posttest	-6.744	22	.000

The paired-sample t-test (Table 5) yielded $t(22) = -6.74$, $p < .001$, indicating a statistically significant difference between the pretest and posttest CT scores. Applying an alpha level of .05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. Based on the reported t value and sample size, the corresponding effect size is large (Cohen's $d_z \approx 1.41$; Cohen, 1988), and the 95% confidence interval for the

mean difference is approximately 19.9 to 37.5 score points. An N-Gain analysis was then conducted to quantify the magnitude of improvement in students' CT skills; the results are presented in Table 6.

Table 6. N-Gain Score Distribution

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	23	.00	1.00	.5444	.31943

Using Hake's (1998) N-Gain formula — the ratio of the actual gain to the maximum possible gain — the mean N-Gain was 0.54 (SD = 0.32), which falls into the medium category ($0.3 \leq g < 0.7$). This indicates a moderate degree of improvement in students' CT skills following the intervention. Specifically, 7 students (30.4%) achieved a high level of improvement ($g \geq 0.70$), 10 students (43.5%) were in the medium category ($0.30 \leq g < 0.70$), and 6 students (26.1%) demonstrated low improvement ($g < 0.30$).

Table 7. Item-Level N-Gain Score

	N	Pretest Mean	Posttest Mean	N-Gain Mean	Category
Item 1	23	9.3478	11.7391	.2391	Low
Item 2	23	10.8696	16.3043	.6594	Medium
Item 3	23	9.7826	14.5652	.5435	Medium
Item 4	23	7.8261	14.1304	.5145	Medium
Item 5	23	8.0435	17.8261	.8406	High

Based on the item-level N-Gain analysis presented in Table 7, student scores improved across all five test items from pretest to posttest. Specifically, four out of the five items demonstrated moderate-to-high growth, with three items falling into the medium N-Gain category (Item 2: $g = .6$; Item 3: $g = .54$; Item 4: $g = .51$) and one item in the high N-Gain category (Item 5: $g = .84$). Meanwhile, Item 1 exhibited improvement in the low category ($g = .24$).

The significant increase in students' CT scores following the map-based unplugged coding intervention is consistent with the study's aim of examining whether this approach is associated with improved computational thinking among third-grade students. Given the absence of a control group, this improvement should be interpreted as an association rather than definitive proof of a causal effect; nevertheless, the pattern of change across the four CT indicators, discussed below, offers a plausible account of how a concrete, map-based unplugged activity may support the development of decomposition, pattern recognition, abstraction, and algorithmic thinking in young learners.

These finding also demonstrate that the enhancement of students' Computational Thinking Skills is connected not only to individual conceptual mastery, but also to opportunities for applying iterative reasoning within concrete contexts. The contrast between pre-treatment and post-treatment conditions indicates that learning experiences involving planning, testing, debugging, and refining steps provide space for students to construct reasoning patterns systematically. Within this instructional framework, students do not merely receive passive explanations of Computational Thinking concepts; rather, they directly practice decomposing problems, recognizing, patterns, abstracting relevant information, and designing algorithmic solutions. Consequently, the observed gain in posttest score reflects a learning process where students actively construct understanding through hand-on actions and contextual problem-solving.

From a pedagogical perspective, this effectiveness confirms that unplugged coding activities are highly adaptable to the cognitive developmental stages of elementary school-aged students. According to Jean Piaget's theory of cognitive development, children aged 7–11 are in the concrete operational stage, during which logical reasoning begins to replace intuitive reasoning, though it remains limited to concrete situations (Wardani, 2022). At this stage, children are already capable of forming concepts, recognizing relationships between objects, and solving problems provided that these activities involve objects and situations familiar to their world (Slavin in Wardani, 2022). It is these developmental characteristics that explain why the concept of programming logic which is initially abstract can be well understood by third-grade students when transformed into a visual spatial representation in the form of a physical grid map, a concrete medium closely related to their daily lives.

The decomposition activities required student break down navigation problems on maps into several simpler steps. When planning a route, students do not immediately map out the entire path; instead, they first divide it into smaller, sequentially arranged segments. This strategy helps students understand the problem

step by step, making it easier to determine a solution. This process aligns with Cognitive Load Theory, which states that working memory has limited capacity. If the information load during learning is too great and exceeds this limit, students' retention of the material will not be optimal (Sweller, 2023). Breaking down problems into smaller units reduces cognitive load, thereby making the information processing more effective (Chen et al., 2023). Quantitatively, this dimension (evaluated in Item 1) showed an increase in mean score from 9.35 to 11.74, yielding a low N-Gain ($g = .24$). Although the gain was lower compared to other dimensions, students still demonstrated foundational progress in decomposing complex routes. This modest gain may indicate that decomposition requires longer practice, although with a single item this interpretation remains tentative.

Pattern recognition skills are developed through activities that involve grouping various buildings based on their characteristics and functions. Students identify common features of buildings such as public facilities, places of learning, shopping centers, and residential homes and then group them into specific categories. This activity helps students learn to identify patterns based on shared characteristics. The ability to recognize patterns was further reinforced through activities involving the identification of patterns and anomalies in navigation codes. In these activities, students not only identified repeating sequences of symbols but also detected instructions that deviated from the general pattern and provided logical explanations for their findings. These activities demonstrated that students were beginning to use patterns as a basis for problem-solving. These findings are consistent with Bruner's enactive stage of learning, which explains that students construct understanding through interaction with concrete objects and visual representations (Umam et al., 2021). This conceptual progress is strongly supported by the empirical data in Item 3, where student scores increased from a pretest mean of 9.78 to a posttest mean of 14.57, achieving a medium N-Gain ($g = 0.54$).

Abstraction skills develop when students are presented with maps of urban environments that contain denser and more complex data. Students were then asked to identify which information should be included in the map and which should not. Abstract skills were also evident when redrawing a travel route, students select only the information they consider important, while ignoring various decorative elements such as trees, flowers, and clouds. This process demonstrates students' ability to distinguish between essential information and irrelevant information. This process is a key characteristic of computational thinking, as students learn to focus on the essential aspects of problem-solving. These findings are consistent with the research by (Azizah et al., 2023), and the empirical evidence from Item 4 reflects this growth, showing a mean score increase from 7.83 to 14.13 ($g = .51$, Medium category), indicating that students became noticeably more proficient at filtering out non-essential map elements.

Algorithmic thinking skills are developed through activities that involve systematically creating travel instructions on a map. Students are asked to determine the sequence of steps from the starting point to the destination so that an object or robot can move accurately without making mistakes. This activity trains students to think logically, systematically, and sequentially. Algorithmic thinking skills are further strengthened through the intergroup debugging process. When there is an error in the sequence of instructions within a group, another group analyzes where the error lies and then provides a solution to correct it. This activity demonstrates that students are not only able to design algorithms, but also to evaluate and improve the algorithms they have created. This is consistent with evidence that unplugged, game-based activities can strengthen algorithmic thinking and debugging skills in primary school children (Brackmann et al., 2017). Quantitatively, this debugging dimension showed a solid improvement, with mean scores rising from 10.87 to 16.30, achieving a medium N-Gain ($g = .66$).

Algorithmic skills were further deepened through conditional logic (If-Then reasoning) and secret map code, where students designed special conditional rules and symbols to represent actions based on specific map conditions before exchanging them with peers to test algorithmic readability and accuracy. Supported by the characteristics of students at the concrete operational stage who can understand others' perspectives during peer discussion (Eggen & Kauchak in Wardani, 2022), this advanced conditional application achieved the highest overall gain, surging from a pretest mean of 8.04 to a posttest mean of 17.83, corresponding to a high N-Gain ($g = 0.84$).

The success of this process is supported by the characteristics of students at the concrete operational stage, who are already able to understand others' perspectives, thereby enabling effective the discussion and peer debugging (Eggen & Kauchak in Wardani, 2022). At the end of the lesson, algorithmic skills were further reinforced through an activity involving the creation of a secret map code. Students created special symbols to

represent buildings and then arranged them into a sequence of travel instructions. Their work was then exchanged with other groups to test the readability and accuracy of the algorithms.

The four Computational Thinking indicators evaluated in this study demonstrate an interconnected and hierarchical relationship. The capacity for decomposition serves as a foundational layer when students encounter complex tasks, as it enables them to deconstruct multi-faceted problems into manageable sub-components. Once these elements are isolated, students leverage pattern recognition to identify similarities, routines, or structural regularities across tasks. The resulting insights then feed directly into the abstraction process, where students filter out extraneous spatial details to prioritize variables essential to primary goal. Subsequently, the outcomes of these analytical steps are translated into systematic, step-by-step procedures through algorithmic thinking. Consequently, the sequentially structured learning activities allow students not only to practice each dimension independently, but also to internalize the functional dependencies among these cognitive skills during problem-solving. This integrated instructional progression is particularly important in elementary education, as early-stage computational thinking appears to develop more effectively through concrete, activity-based instruction rather than through abstract, definition-based instruction alone.

These findings regarding the effectiveness of the map-assisted unplugged coding approach are consistent with the study by Handayani & Nirmala (2025), which showed that unplugged coding activities successfully helped elementary school students meet four indicators of computational thinking. This finding is reinforced by the results of Ningrum et al. (2026), which show that unplugged coding instruction not only boosts test scores but also improves students' logical thinking processes and basic decision-making skills. The success of this implementation is further supported by the results of a Systematic Literature Review (SLR) by Sari et al. (2026), which confirms that unplugged coding is not merely a low-cost alternative but a pedagogically sound strategy for elementary schools. Taken together, these findings are broadly consistent with the present results, although direct comparison is limited because these studies differ in subject matter, duration, and design; further research directly comparing effect sizes would strengthen this line of evidence.

Another distinct advantage of implementing map-assisted unplugged coding lies in its instructional context, which seamlessly integrates computational thinking skills with content already familiar to student. Utilizing maps as a learning context allows spatial concepts such as as direction, position, route, and location to serve not merely as Social Studies content, but as contextual problem representations that can be processed using computational thinking principle. This integration offers a cross-disciplinary learning experience, as students simultaneously draw upon spatial knowledge and reasoning skills to achieve specific problem-solving goals. These findings indicate that the development of Computational Thinking does not need to be positioned as an isolated, standalone subject. Instead, it can be embedded within existing curricula by designing activities that enable students to engage in systematic problem-solving. Furthermore, this approach provide educators with practical opportunities to cultivate Computational Thinking without restructuring the entire curriculum or requiring specialized computing hardware.

Theoretically, this study contributes to the development of research on computational thinking at the elementary school level. The findings indicate that unplugged coding activities using physical map can facilitate the development of computational thinking skills among third-grade students who are at the concrete operational stage. These findings expand our understanding of the Computational Thinking literature, which has so far placed greater emphasis on the use of digital devices such as the Scratch platform (Nurhopipah et al., 2021; Rodríguez-Martínez et al., 2020; Zahid et al., 2021), the integration of artificial intelligence technologies such as Canva AI (Maulah et al., 2025), and the use of the interactive website Code.org (Permatasari et al., 2026). These findings extend the unplugged-coding literature by demonstrating its applicability within Social Studies map-reading content specifically, suggesting that algorithmic thinking and related reasoning skills can also be fostered through concrete, device-free activities suited to elementary school students' developmental characteristics; this contribution should, however, be interpreted in light of the single-class, single-context design of the present study.

In practical terms, the unplugged coding approach used in this study appears to be a learning alternative that is relatively easy to implement, interactive, and independent of technological devices, and it may help schools with limited digital resources incorporate computational thinking into their instruction.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the One-Group Pretest-Posttest design lacked a control group, so the observed gains in computational thinking

cannot be attributed solely to the unplugged coding intervention; testing effects (from taking the same test twice) and concurrent classroom learning may also have contributed. Second, the computational thinking instrument comprised only five items, with three of the four indicators represented by a single item each; this limits the precision of indicator-level claims and may affect score reliability. Third, three students (11.5% of the initial cohort) were excluded from the analysis owing to absence, and their potential influence on the results was not formally examined. Fourth, the study was conducted over five sessions in a single class at one school, which constrains the generalizability of the findings to other grades, schools, and contexts. Future studies employing a control-group design, a more comprehensive instrument, and a larger, more diverse sample are needed to corroborate these findings.

The medium N-Gain classification suggests that computational thinking skills may develop further with extended intervention durations and more consistent practice. Building on the limitations noted above, we recommend that future studies use a randomized or matched control-group design, a more comprehensive multi-item instrument for each CT indicator, and a larger, more diverse sample; combining unplugged coding with cooperative learning strategies such as heterogeneous grouping, peer tutoring, and differentiated instruction may also help produce more consistent gains across students of varying ability.

CONCLUSION

This study examined the difference in third-grade elementary school students' computational thinking (CT) skills before and after learning that integrated unplugged coding with map media in Social Studies. The mean CT score increased from 45.87 (pretest) to 74.56 (posttest), a statistically significant difference, $t(22) = -6.74$, $p < .001$, $d \approx 1.41$, with a mean N-Gain of 0.54 (medium category). These findings indicate that map-based unplugged coding was associated with an improvement in computational thinking among third-grade students, consistent with gains across the decomposition, pattern recognition, abstraction, and algorithmic thinking indicators discussed above. Because the design lacked a control group and involved a single class over five sessions, this improvement should be interpreted with caution and not attributed solely to the intervention. Future research using a control-group design, a more comprehensive instrument, and a larger sample is recommended to confirm the effectiveness of map-based unplugged coding for developing computational thinking in elementary school students.

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