THE EFFECT OF COMPUTATIONAL THINKING-BASED E-LKM ON IMPROVING LEARNING OUTCOMES RELATED TO NUMERACY LITERACY SKILLS AMONG ELEMENTARY SCHOOL STUDENTS

Farhan Iqbal Pratama[1], Sri Sumartiningsih[2]
[1,2]Pendidikan Dasar, Sekolah Pascasarjana, Universitas Negeri Semarang
[1]fipratama77@students.unnes.ac.id, [2]sri.sumartiningsih@mail.unnes.ac.id

ABSTRACT

The study aims to analyze the effect of computational thinking-based electronic student worksheets (E-LKM) on improving cognitive learning outcomes related to elementary students' numeracy literacy skills. This research employed a quantitative, pre-experimental design with a one-group pretest-posttest method. The sample consisted of 22 fifth-grade students. Data were collected through numeracy literacy tests, while data analysis was conducted using the N-Gain test and the Wilcoxon Signed-Rank test. The results showed an increase in the average score from 46.02 to 57.61, with a significance value of 0.000 (<0.05). These findings indicate that computational thinking-based E-LKM has a significant effect on improving students' numeracy literacy skills and cognitive learning outcomes.

***Keywords**: computational thinking, e-lkm, learning outcomes, numeracy literacy*

ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh E-LKM berbasis computational thinking terhadap peningkatan hasil belajar kognitif terkait kemampuan literasi numerasi murid sekolah dasar. Penelitian ini menggunakan pendekatan kuantitatif dengan desain pre-eksperimental dengan metode one-group pretest-posttest. Sampel penelitian berjumlah 22 murid kelas V. Teknik pengumpulan data dilakukan melalui tes literasi numerasi, sedangkan analisis data menggunakan uji N-Gain dan uji Wilcoxon Signed-Rank. Hasil penelitian menunjukkan adanya peningkatan rata-rata nilai dari 46,02 menjadi 57,61 serta nilai signifikansi sebesar 0,000 (<0,05). Temuan ini mengindikasikan bahwa E-LKM berbasis computational thinking berpengaruh signifikan dalam meningkatkan kemampuan literasi numerasi dan hasil belajar kognitif murid.

Kata Kunci: computational thinking, e-lkm, hasil belajar, literasi numerasi

A. INTRODUCTION

Amid the rapid pace of technological advancement in the 21st century, elementary school education now bears a greater responsibility than simply transferring knowledge. It is no longer limited to the formal school environment; rather, it focuses on how students' abilities can be developed to meet the demands of the times. It is no longer enough for students to merely be users of technology; they must be equipped with higher-order thinking skills (HOTS). 21st-century digital education demands that elementary school students possess critical thinking skills, sharp reasoning, and the independence to solve problems. (Mee et al., 2025). This is important so that they do not get lost in the complexities of the digital ecosystem, which is rife with misinformation and rapid change.

The foundation of these skills lies in the synergy between digital literacy and computational thinking (Rozana, 2025). In this context, digital literacy equips them with the ethical awareness and discernment needed to navigate the online world. Meanwhile, computational thinking trains the mind to break down complex problems into smaller, more manageable parts that can be systematically addressed. The integration of these two aspects fosters an adaptive and solution-oriented mindset.

Digitalization is ushering in a new era in literacy and numeracy education. Learning, which was once limited to textbooks, can now be accessed via devices with internet connectivity. Numeracy is understood not merely as the ability to perform calculations, but as the skill to use numbers and mathematical concepts to solve contextual problems, interpret data, analyze graphs and tables, and make decisions in real-world situations (Iswara dkk., 2022; Ramdhani dkk., 2024). Strong numeracy skills directly contribute to academic success and decision-making in the daily lives of elementary school students (Anggraini dkk., 2025; Anggun dkk., 2025). High levels of numeracy literacy enable students to solve more complex contextual problems without being misled by data, and help them think and communicate their reasoning in a more critical, meticulous, and systematic manner (Ndasi dkk., 2025; Pratiwi dkk., 2024).

In addition to being a global educational trend, computational thinking (CT) has been recognized as a key 21st-century skill for children from an early age. CT encompasses problem decomposition, pattern recognition, abstraction, and algorithm design as a systematic approach to problem-solving across various fields, not just programming (Mee et al., 2025). The relevance of CT is crucial due to its interdisciplinary nature, particularly in strengthening numeracy skills. The integration of CT into the elementary school curriculum prepares students to face the challenges of a fully digital future. By mastering this way of thinking, students do not merely become passive consumers of technology but grow into reliable problem-solvers across various aspects of life. The ability to formulate logical steps (algorithms) to solve school assignments and everyday problems is a valuable asset that will shape their character as adaptive, solution-oriented learners in the 21st century.

Studies in Indonesia show that integrating CT into AKM helps students understand question structure, develop strategies, and answer more accurately. This helps strengthen students' analytical and strategic skills (Adiyastuti dkk., 2024). Research on the relevance of computational thinking in K-12 mathematics has found that Math-CT activities foster mutually reinforcing mathematical and computational thinking processes, such as when students develop algorithms to solve number or geometry problems (Ye et al., 2023).

Numeracy and computational thinking skills are key competencies for 21st-century students in solving real-life problems. However, international studies indicate that Indonesian students' numeracy skills still lag behind. This is evidenced by PISA results in mathematics, which are well below the OECD average, highlighting the need for targeted interventions to improve numeracy in elementary schools (Anggraini dkk., 2025). Literacy and numeracy achievement in elementary schools in Indonesia remains low due to the prevalence of traditional teaching methods and limited use of technology (Anggun dkk., 2025; Ramdhani dkk., 2024).

The 2023 PISA results still place Indonesia at a low ranking. The average PISA score in numeracy is

366 points, 106 points below the global average (Yuda & Rosmilawati, 2024). Research on numeracy literacy has been conducted on several occasions. One such study was conducted by Zainudin et al., who examined trends in literacy and numeracy in elementary schools. The topics analyzed were the implementation of literacy and numeracy (45%), literacy and numeracy activities themed around daily life (41.67%), and literacy and numeracy activities using the case study method (35%). Patterns of literacy and numeracy integration with contextual learning (38.46%), interest in literacy and numeracy (58.33%), and literacy and numeracy problem-solving (16.67%) (Zainudin dkk., 2023).

The limited implementation of technology in education indicates that teaching and learning have not yet kept pace with the times. The use of student worksheets in the classroom remains conventional, static, and procedure-oriented, and thus fails to adequately support students in the exploration, reasoning, and systematic thinking required for higher-order thinking skills (HOTS) and critical thinking (CT). (Solihin dkk., 2024). In fact, electronic student worksheets (E-LKM) designed based on the principles of cognitive activities have been shown to improve adaptive reasoning and understanding of mathematical concepts (Saraswati et al., 2025). Learning integrated with digital technology can improve cognitive learning outcomes and problem-solving skills among elementary school students (Adam dkk., 2025; Mayadesti & Yeliza, 2025).

Although E-LKM is already widely used and has positive potential for students' cognitive development, the development of E-LKM is still limited to the subject matter being taught or the creation of the product itself, and has not yet specifically integrated learning steps based on the four foundations of CT to simultaneously stimulate numeracy literacy skills and cognitive learning outcomes. Therefore, to meet these 21st-century skills, there is a need for E-LKM innovations that integrate CT into problem-solving related to numeracy literacy for elementary school students. Interactive E-LKM innovations offer a more engaging learning experience through interactive tasks that enhance attention and motivation and improve

elementary school students' learning outcomes. (Afifah & Junaedi, 2024; Daryanto dkk., 2022).

The E-LKM, which integrates the CT stages into numeracy activities, is expected to train students to think systematically while improving their conceptual understanding and procedural accuracy. This study aims to contribute to the body of educational research by improving the numeracy literacy skills and cognitive learning outcomes of elementary school students, an area that has not yet been extensively studied.

Given this background, this study aims to analyze the effect of using computational thinking-based E-LKM on the cognitive learning outcomes related to numeracy literacy among elementary school students. The integration of CT in the context of numeracy is supported by findings that CT is strongly associated with numeracy, reasoning, and other cognitive skills in students aged 7–12 years, and that the integration of CT in STEM learning has a moderately significant effect on cognitive skills.

B. METHOD

This study employs a quantitative approach using a pre-experimental design. This design utilizes a one-group pretest-posttest method. It is a quantitative research design that involves only one experimental group, in which comparisons are made by examining changes from pretest to posttest. (Sugiyono, 2022). The following is the research design diagram used.

$$O_1 \; X \; O_2$$

Description:

O_1 = pretest scores before the treatment.

X = *treatment*, the use of CT-based E-LKM.

O_2 = posttest scores after the treatment.

This study was conducted at SD Negeri 2 Bulurejo, Gadingrejo Subdistrict, Prungsewu Regency, Lampung. The study population consisted of all fifth-grade students, with Class VA serving as the sample. Random sampling was used for the sampling technique. Data collection was conducted through pretests and posttests of learning outcomes using numeracy literacy tests in accordance with the E-LKM, which was the subject of the study. Data analysis techniques included tests of normality as a

prerequisite, the N-Gain test (knowledge gain), and a non-parametric test using the Wilcoxon Signed-Rank Test to test the hypothesis regarding the effect of CT-based E-LKM on learning outcomes related to literacy and numeracy.

C. RESULTS AND DISCUSSION

This study was conducted in Class VA of State Elementary School 2 Bulurejo, Pringsewu Regency, during the 2025/2026 academic year, specifically in March 2026. Instruction was delivered in a single experimental class using an E-LKM based on computational thinking (CT).

Based on the research data, it was found that, among 22 students in Class VA, the average pretest learning outcome was 46.02. After the intervention using CT-based E-LKM, the average learning outcome increased to 57.61. Although the increase did not reach 70 (KKTP), the results indicate that the use of CT-based E-LKM has the potential to improve students' numeracy literacy outcomes. To explore the results further, the following presents the hypothesis testing.

Prerequisite Test

The following data presents the results of the normality test, which is a prerequisite for hypothesis testing. The normality test was conducted to determine whether the population data follow a normal distribution. (Sugiyono, 2022). A normality test was conducted using the Shapiro-Wilk test because the sample size was less than 50 (Habibzadeh, 2024). The Shapiro–Wilk test is considered one of the most robust tests of normality, especially for small to medium-sized samples (Khatun, 2021).

Table 1. Normality Test Results

Tests of Normality

Category		Shapiro-Wilk		
		Statistic	df	Sig.
Score	Pretest	0,977	22	0,858
	Posttest	0,895	22	0,024

Source: The researchers' analysis was conducted using SPSS version 26.

Hypothesis Testing

It is known that the pretest data are normally distributed, whereas the posttest data are not normally distributed in the experimental class. Next, hypothesis testing was conducted, which is a step in statistical data analysis. Hypothesis testing can help determine whether the observed phenomena actually occurred or are merely theoretical (Anuraga dkk., 2021). Hypothesis testing in this study employed a non-parametric test,

specifically the Wilcoxon Signed-Rank test, to examine differences before and after the intervention.

The Wilcoxon Signed-Rank Test is the primary nonparametric tool for paired or single-sample data when the assumption of normality is in doubt. The Wilcoxon test is at least as powerful as the t-test for normally distributed data and performs better for non-normal distributions. (Garren & Davenport, 2022). The following are the results of the hypothesis testing.

Table 2. Ranks Wilcoxon Testing

Ranks

		N	Mean Rank	Sum of Ranks
Pretest-Posttest	Negative Ranks	0[a]	0,00	0,00
	Positive Ranks	22[b]	11,50	253,00
	Ties	0[c]		
	Total	22		

a. Posttest < Pretest
b. Posttest > Pretest
c. Posttest = Pretest

Source: The researchers' analysis was conducted using SPSS version 26.

Based on Table 2, the results show that the change in data from the pretest to the posttest, as indicated by the ranks, suggests a positive trend (positive ranks). This indicates that 22 students improved their scores. Since this figure encompasses the entire sample, it can be concluded that the use of CT-based E-LKM can improve students' numeracy literacy outcomes.

Table 3. Wilcoxon Signed-Rank Testing

Test Statistics[a]

	Posttest - Pretest
Z	-4,120[b]
Asymp. Sig. (2-tailed)	0,000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Source: The researchers' analysis was conducted using SPSS version 26.

Based on Table 3, the results of the hypothesis test show that the Asymp.Sig. (2-tailed) value is less than the significance level α (0.000 < 0.05), which means that the alternative hypothesis (Ha) is accepted. This indicates a highly significant difference between the pretest and posttest results. In practical terms, the CT-based E-LKM intervention had a tangible impact on improving students' numeracy literacy outcomes at SD Negeri 2 Bulurejo.

N-Gain Testing

Based on the results of the N-Gain test administered to 22 students, the average N-Gain score was 0.20. According to the N-Gain interpretation criteria, this score falls into the low category. This indicates that the improvement in learning outcomes following the use of computational thinking-based E-LKM remains limited.

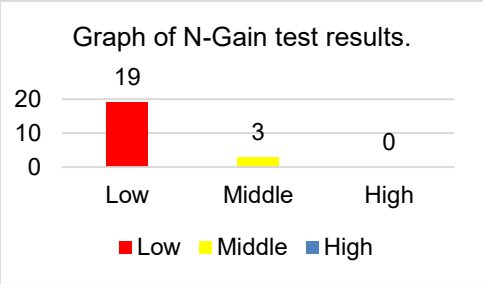

Figure 1. Graph of N-Gain test results

The distribution of N-Gain test results shows that the majority of students fell into the low category—19 students (86%)—while 3 students (14%) fell into the moderate category, and no students reached the high category. This indicates that the improvement in learning outcomes observed following the use of a computational thinking-based E-LKM remains predominantly concentrated in the low category.

Although all students showed improved learning outcomes (as indicated by positive N-Gain scores), most of these improvements have not yet reached an optimal level. Nevertheless, the fact that some students fall into the moderate category suggests that computational thinking-based E-LKM has the potential to improve learning outcomes if implemented more intensively and sustainably.

Overall, the results of this N-Gain test support the hypothesis that the use of E-LKM based on computational thinking can improve student learning outcomes; however, the extent of this improvement still needs to be optimized to reach the moderate or high categories.

The results of the study indicate that the use of E-LKM based on computational thinking (CT) has a significant impact on improving cognitive learning outcomes related to elementary school students' numeracy skills. This is evidenced by an increase in the average score from 46.02 on the pretest to 57.61 on the posttest, and is further supported by the results of the Wilcoxon Signed-Rank test, which showed a significance level of 0.000 (<0.05). Scientifically, these findings indicate that integrating CT into digital learning media can make a tangible contribution to improving the quality of numeracy learning. This improvement occurs because E-LKM functions not only as a medium for delivering content but also as a tool for activating higher-order thinking processes involving analysis, evaluation, and the development of problem-solving strategies.

Conceptually, this improvement in learning outcomes can be attributed

to the key characteristics of computational thinking, namely decomposition, pattern recognition, abstraction, and algorithms. In the learning process using CT-based E-LKM, students are trained to break down complex numeracy problems into simpler parts (decomposition), identify patterns or relationships between data (pattern recognition), filter relevant information (abstraction), and systematically organize solution steps (algorithms). This process directly strengthens numeracy skills because students focus not only on the final result but also on understanding the thought process behind problem-solving. (Sari dkk., 2025). As a result, learning becomes more meaningful and fosters the development of logical and systematic thinking skills.

Furthermore, the results of this study show that all students improved their scores (positive ranks), indicating that the intervention had an equitable impact across the entire sample. This suggests that CT-based E-LKM is inclusive and adaptive in accommodating students' varying ability levels. Pedagogically, the use of CT-based E-LKM provides students with the opportunity to learn actively through exploration and direct interaction with contextual problems (Prihandono dkk., 2023). This activity aligns with the constructivist approach, in which students construct their own knowledge through meaningful learning experiences. Additionally, the interactivity in E-LKM enhances student motivation and engagement, thereby positively impacting learning outcomes.

However, despite a significant improvement, the average learning outcomes achieved have not yet met the established proficiency criteria (KKTP ≥ 70). This indicates that the effectiveness of CT-based E-LKM still needs to be optimized. One factor that may explain this situation is the need to adapt to a new learning model. Students accustomed to conventional learning tend to need time to adjust to a problem-solving approach that demands greater cognitive engagement. Additionally, the complexity of tasks in CT-based E-LKM can increase students' cognitive load, especially if not balanced by adequate teacher scaffolding. Another contributing factor is the relatively short duration of the intervention, which is insufficient to demonstrate optimal effects on learning outcomes.

The findings of this study are consistent with various previous studies showing that integrating computational thinking into mathematics and numeracy instruction can enhance students' analytical thinking and problem-solving skills. A study by Adiyastuti et al. demonstrates that CT helps students understand the structure of numeracy problems and develop more effective solution strategies (Adiyastuti dkk., 2024). Meanwhile, Ye et al. found that integrating CT into mathematics education can simultaneously develop mathematical and computational thinking skills (Ye dkk., 2023). In addition, studies by Ramdhani et al. and Mayadesti & Yeliza also confirm that the use of interactive digital learning media significantly contributes to improvements in elementary school students' cognitive learning outcomes and numeracy skills (Mayadesti & Yeliza, 2025; Ramdhani dkk., 2024).

The implications of this study are that the use of E-LKM not only supports the mastery of numeracy concepts but also develops critical, logical, and systematic thinking skills that are essential for addressing the challenges of the digital age. Therefore, teachers should be encouraged to develop and implement CT-based E-LKM more widely in their teaching. Additionally, support is needed through teacher training, the development of more structured learning materials, and sustained integration to ensure that the results achieved are as optimal as possible.

Overall, the findings of this study confirm that integrating computational thinking into E-LKM is an effective strategy for improving elementary school students' numeracy literacy and cognitive learning outcomes. Nevertheless, implementation still needs to be optimized by strengthening instructional design, increasing intervention duration, and providing adequate pedagogical support. Thus, CT-based E-LKM has great potential to serve as an innovative solution for improving the quality of elementary education in the digital age.

In addition to yielding significant findings, this study also has several limitations that should be noted. First, the research design was a pre-experimental one-group pretest-posttest design without a control group, so it was not able to fully eliminate external variables that could

influence the results. This implies limitations in drawing strong causal conclusions regarding the effectiveness of computational thinking-based E-LKM. Second, the relatively small sample size—only 22 students in a single class—limits the generalizability of the findings and does not adequately represent a broader population. Third, the relatively short duration of the intervention also contributes to the suboptimal improvement in student learning outcomes, meaning the long-term effects of using computational thinking (CT)-based E-LKM remain incompletely understood. Fourth, this study focused solely on cognitive and numeracy literacy, without thoroughly examining other aspects such as learning motivation, attitudes toward mathematics, or students' metacognitive skills. Furthermore, the level of teachers' readiness to implement CT-based E-LKM has not been systematically analyzed, even though this factor significantly influences learning success.

Given these limitations, future research is recommended to employ a stronger experimental design, such as a quasi-experimental or true experimental design with a control group, to provide more valid causal evidence. Additionally, a larger sample size and the inclusion of various schools with different characteristics are necessary to enhance the generalizability of the research findings. Further research is also recommended to extend the intervention duration to observe the long-term impact of computational thinking-based E-LKM on students' numeracy development.

In addition, it is important to integrate other variables, such as learning motivation, critical thinking skills, and metacognition, to obtain a more holistic picture of learning effectiveness. Future research could also explore the development of more adaptive and differentiation-based E-LKM designs, as well as examine the role of teachers as facilitators in implementing computational thinking in the classroom. Thus, future research findings are expected to provide a more comprehensive contribution to the development of technology-based learning innovations in elementary schools.

D. CONCLUSION

Based on the research findings and discussion, it can be concluded

that the use of computational thinking-based E-LKM significantly improves elementary school students' numeracy literacy outcomes. This is demonstrated by a significant difference between pretest and posttest scores, as determined by the Wilcoxon test with a significance level of < 0.05, indicating that the research hypothesis is accepted.

Empirically, all students experienced improved learning outcomes after receiving the intervention, indicating that integrating computational thinking stages into E-LKM helps students formulate problems, reason logically, and systematically develop solution steps. Thus, CT-based E-LKM not only supports digital learning but also serves as a tool for developing students' skills that support literacy and numeracy.

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