

The Effectiveness of Problem Solving Based Student Worksheets in Improving Elementary School Students' Computational Thinking Skills: A Gender Perspective Analysis to Support the Achievement of SDGs 5

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Abstract: This study aims to determine the effectiveness of problem-solving-based Student Worksheets in improving the computational thinking skills of fourth-grade elementary school students on the topic of fractions. This study employs a pre-experimental method with a quantitative approach using a One Group Pretest–Posttest Design. The research subjects consisted of 23 fourth-grade students at SDN Sonokwijenan II/96. Data were collected through questionnaires as well as pretest and posttest instruments. The results showed a significant improvement in students' computational thinking skills, with the average score increasing from 40 on the pretest to 65.32 on the posttest. The paired t-test results showed a significance value of $0.001 < 0.05$, indicating a statistically significant difference. The N-Gain score was 0.42, which falls into the moderate category, and Cohen's d effect size was 1.180, indicating a very strong effect. These findings indicate that the developed problem-solving-based worksheets meet the criteria of being valid, practical, and effective in enhancing students' conceptual understanding and learning outcomes in fractions. These worksheets are designed to systematically integrate problem-solving stages, thereby helping students understand problems, formulate solution strategies, and evaluate the results obtained.

Keywords: computational thinking; fractions; student worksheets; problem solving; elementary school

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INTRODUCTION

The development of the Industrial Revolution 4.0 and Society 5.0 has transformed perspectives on education, shifting the focus from mastering knowledge to emphasizing the development of 21st-century competencies. Today, students are not only required to master academic concepts but must also possess critical thinking, creative, collaborative, and communicative skills, as well as the ability to solve various problems systematically by leveraging technology. One competence currently receiving significant attention in the educational world is Computational Thinking (CT)—the ability to solve problems logically through the processes of decomposition, pattern recognition, abstraction, and algorithm design. This capability is considered a fundamental skill that must be instilled from primary education, serving as an essential foundation for facing life's challenges, digital technology developments, and the transformation of the future workforce (Lin & Wong, 2024).

In the context of primary education, mathematics instruction plays a vital role as a vehicle for developing logical, analytical, systematic, and creative thinking skills. However, numerous studies indicate that mathematics learning in elementary schools is still dominated by procedural approaches that place greater emphasis on solving problems mechanically. As a result, students tend to memorize step-by-step solutions without understanding the underlying concepts or thinking processes. This situation is supported by data from the 2022 Programme for International Student Assessment (PISA), which revealed that the average mathematics score of Indonesian students reached only 366, well below the OECD average of 472. Furthermore, only 18% of Indonesian students were able to reach Level 2 or higher in mathematical literacy, compared to the OECD average of 69%. These results indicate that the majority of Indonesian students still experience difficulties in understanding, representing, and solving mathematical problems that require reasoning and problem-solving strategies (PISA, 2022). Consequently, students' computational thinking skills have not developed optimally, particularly on the topic of fractions, which requires analytical ability, concept representation, and step-by-step problem-solving. Yet, fractions are a foundational concept that serves as a prerequisite for mathematics learning at subsequent levels (Solihin et al., 2024).

An innovation that can be implemented in instruction is problem-solving-based Student Worksheets (LKPD), which are considered capable of meeting these needs by providing opportunities for students to construct their knowledge through active problem-solving processes. The Problem-Solving model places students at the center of the learning process through the stages of understanding the problem, planning a solution strategy, executing the solution, and reflecting on the obtained results. These stages align with the core components of Computational Thinking: decomposition, pattern recognition, abstraction, and algorithmic thinking. Therefore, the integration of Problem-Solving-based worksheets is believed to enhance students' computational thinking skills more effectively than conventional teaching methods (Pratiwi et al., 2026).

Conversely, the development of computational thinking skills is not only related to the effectiveness of instructional models but is also deeply linked to gender equality issues in education. Over the past few decades, the fields of Science, Technology, Engineering, and Mathematics (STEM) have continued to exhibit gaps in participation and achievement between males and females. This situation has led to assumptions that computational and problem-solving abilities are predominantly possessed by male students. However, various recent studies demonstrate that gender-based differences in computational thinking skills are not always consistent and are strongly influenced by the learning environment, instructional strategies, and learning opportunities provided to students. Thus, appropriate instructional design has the potential to reduce or even eliminate these gaps (Angeli & Georgiou, 2023).

Research conducted by Gunawan et al. (2023) on elementary school students in Indonesia indicates that gender can influence certain aspects of computational thinking skills. However, these differences are relatively small and not uniform across all computational thinking indicators. Recent meta-analysis results involving over nine thousand students across various countries also found that the effect size of computational thinking differences between males and females is low. Therefore, instructional factors exert a far more significant impact than biological factors. These findings imply that teachers play a critical role in creating an inclusive learning environment and providing equal opportunities for all students to develop computational thinking skills regardless of gender.

Although numerous studies have examined the development of Computational Thinking in mathematics learning and the implementation of the Problem-Solving model, most of these studies still focus on improving general computational thinking skills without considering gender equity. On the other hand, research on the use of Problem-Solving-based Student Worksheets on fractions in elementary schools remains limited, particularly studies that integrate the development of Computational Thinking with a gender-based analysis. In addition, most previous studies have only evaluated the effectiveness of instructional models on mathematics learning outcomes, while studies investigating their impact on specific Computational Thinking indicators among elementary students remain relatively sparse. Therefore, research is needed to examine the effectiveness of Problem-Solving-based worksheets in improving the computational thinking skills of fourth-grade elementary students while analyzing the results through a gender perspective. This study is expected to contribute to the development of mathematics learning strategies that are more innovative, inclusive, and supportive of equal learning opportunities for all students.

METHODS

This study employs a pre-experimental method with a quantitative approach using a One Group Pretest–Posttest Design (Creswell, 2023). The focus of this research is to analyze the effectiveness of using Problem-Solving-based Student Worksheets (LKPD) in enhancing computational thinking skills among elementary school students, as well as to identify improvements in these skills from a gender perspective. Data regarding computational thinking skills were obtained using a test instrument designed based on four core indicators of Computational Thinking: decomposition, pattern recognition, abstraction, and algorithmic thinking. Furthermore, this study utilizes an instructional implementation observation sheet to ensure that the implementation of the Problem-Solving model adheres to the established learning syntax, alongside using Problem-Solving-based LKPD as the primary media in the learning process. The active learning model supporting problem-solving in the LKPD was executed by applying an active learning problem-solving model. The design used in this study is the One Group Pretest-Posttest Design presented in Table 1 below.

Table 1 *One Group Pretest-Posttest*

<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
O ₁	X	O ₂

This study involved 23 fourth-grade elementary school students, consisting of 15 male students (65.22%) and 8 female students (34.78%).

Table 2 Jumlah Siswa Kelas IV Sekolah Dasar

Gender	Jumlah	Persentase
Laki-laki	15	65,22
Perempuan	8	34,78
Total	23	100

All students were given a pretest to evaluate their initial computational thinking skills before participating in learning using the Problem-Solving-based LKPD. After the entire learning process was completed, students took a posttest to measure the improvement in their computational thinking skills. The data were then quantitatively analyzed using IBM SPSS Statistics version 27, applying descriptive statistical analysis, the Shapiro–Wilk normality test, Paired Sample t-Test, Normalized Gain (N-Gain), Effect Size (Cohen's d), and Independent Sample T-Test to compare the improvement in computational thinking skills between male and female students. All statistical tests were conducted at a significance level of $\alpha = 0.05$.

RESULTS & DISCUSSIONS

Problem-solving-based Student Worksheets (LKPD) are designed to present contextual problems relevant to daily life, thereby helping students gain a deeper understanding of mathematical concepts. Engaging students in problem-solving activities within these worksheets provides opportunities to identify problems, plan solution strategies, execute calculations, and evaluate their results. This approach aligns with the core characteristics of elementary school mathematics education, which emphasizes the development of critical thinking and problem-solving abilities. Previous literature indicates that implementing problem-solving-oriented worksheets enhances students' mathematical problem-solving skills. Specifically, Loviana and Yunarti (2025)

demonstrated that developing problem-based worksheets in mathematics instruction yields a positive impact on elementary students' problem-solving skills and encourages more active participation in the learning process. Furthermore, empirical evidence shows that problem-based worksheets improve student learning outcomes, with average scores increasing from 55.38 on the pretest to 70.14 on the posttest (Alawiyyah et al., 2024). These findings collectively indicate that problem-solving-based LKPD creates a more active, contextual learning environment while strengthening students' conceptual grasp of elementary mathematics.

In this study, the problem-solving-based LKPD was specifically developed for teaching fractions to fourth-grade elementary students. In mathematics education, learning materials designed around problem-solving help students construct meaningful conceptual understanding because learners shift from passive receivers of information to active agents in discovering solutions (Kurniawati et al., 2023). Beyond conceptual mastery, problem-solving LKPD fosters higher-order thinking skills. The decision to develop this instructional tool stemmed from baseline needs analyses—conducted via teacher and student observations and interviews—which revealed that fraction instruction heavily relied on conventional textbooks and lecture-based methods. This teacher-centered approach resulted in low student engagement and failed to provide concrete, contextual representations of fraction concepts (Julfianto et al., 2022). Consequently, students exhibited low participation and suboptimal learning achievements. Developing a problem-solving LKPD serves as an alternative learning resource that encourages student agency while guiding them through fraction concepts systematically.

Field observations confirmed that elementary students struggle with abstract mathematical concepts, particularly fractions. This highlights the necessity of instructional resources that ground abstract ideas into concrete representations and stimulate active involvement. Structured, activity-based worksheets guide students through systematic learning tasks that require cognitive engagement. Prior research corroborates that activity-based worksheets enhance students' thinking and problem-solving capacities; for instance, Munawaroh et al. (2024) observed significant gains in students' mathematical problem-solving skills following problem-focused instruction, recording average skill improvements of 17.95% in the first cycle and 31.85% in the second cycle.

Similarly, Trisnawati et al. (2025) reported that instructional models centered on problem-solving activities significantly boosted student learning outcomes, elevating average scores from 58.50 to 75.50 and increasing mastery learning percentages from 43.75% to 87.50%. These trends confirm that problem-solving activities foster deeper conceptual understanding and active participation. Addressing these pedagogical gaps, the problem-solving LKPD in this study was tailored to the developmental characteristics of elementary students to scaffold their understanding of fractions in a structured manner.

As a pedagogical tool, problem-solving-based LKPD promotes higher-order thinking skills through systematic problem-solving phases: active observation, problem analysis, solution planning, and outcome evaluation (Aulia & Rukmana, 2023). Furthermore, exposure to real-world, contextual problems boosts learning motivation and mathematical application skills (Marchy et al., 2022b). Accordingly, integrating these structured stages in the developed LKPD was aimed at reinforcing students' computational thinking skills.

The classroom implementation was guided by the developed teaching modules and problem-solving LKPD. Prior to instruction, a pretest assessed students' baseline understanding. Introductory activities included opening prayers, national anthems, and contextual icebreaker questions to activate prior knowledge. During the core phase, students worked in heterogeneous small groups. Cooperative learning within heterogeneous groups enhances peer interaction, communication, and social skills during problem-solving (Daiyah et al., 2024), while providing a platform to exchange diverse perspectives and develop higher-order thinking (Salamah et al., 2024).

The group implementation revealed marked increases in student confidence during LKPD discussions. Students actively shared ideas, posed questions, and responded to peers within a supportive group climate. Ability-based heterogeneous grouping also cultivated mutual respect, as evidenced by students actively listening, refraining from dominating conversations, and constructively addressing differing opinions. Thus, group-based LKPD activities cultivated both cognitive problem-solving capacities and essential collaborative social skills.

Using problem-solving LKPD transformed the classroom into an active, student-centered learning environment. The worksheet systematically guided students through understanding problems, planning solutions, applying strategies, and drawing conclusions. Collaborative group work allowed students to test multiple solution paths

collectively, a combination proven to enhance computational thinking skills and active engagement (Khoiri, 2023). Furthermore, structured problem-solving frameworks elevate the quality of students' reasoning processes (Indrawsari & Rahmat, 2022).

Observational findings during implementation demonstrated high student enthusiasm across all learning stages—from problem identification and group discussion to presenting their final solutions. Active participation was evident as students extracted key information, designed strategies, and explored alternative solutions collaboratively. Direct involvement in concept discovery enhanced learning motivation, prompting students to understand the material deeply to contribute meaningfully to their groups. The resulting dynamic, peer-supported environment focused student attention on systematic thinking processes and collaboration rather than merely arriving at a final answer.

The structured sequence of activities effectively bridged conceptual understanding and academic performance. Contextual problem-solving deepened fraction comprehension by connecting abstract rules to daily life situations, supporting findings by Setyani and Susilowati (2022) regarding the role of real-world contexts in boosting computational thinking and active engagement. Additionally, training students to approach problems systematically leads to measurable improvements in learning outcomes (Li et al., 2024).

Post-implementation feedback from student questionnaires evaluated the readability, usability, and perceived usefulness of the LKPD. Teacher questionnaires assessed practical implementation in the classroom. Student responses indicated that the majority felt more engaged and understood fraction concepts more easily using the problem-solving LKPD. These perceptions align with literature indicating that problem-based LKPD enhances motivation and conceptual grasp through active individual and group discovery (Ardiari et al., 2023).

The feasibility of the developed LKPD was validated across three parameters: validity, practicality, and effectiveness. Expert judgment by media and content experts confirmed high validity, with media experts rating the worksheet at 91.66% ("highly valid") and content experts at 90% ("highly valid"). Expert recommendations were incorporated to refine the product prior to testing, including: (1) revising fourth-grade fraction content depth, (2) improving table of contents formatting, (3) aligning learning outcome sequences, (4) streamlining dialogue in the fraction comic section for clarity, (5)

correcting text punctuation, (6) standardizing color schemes and visual layouts for consistency, and (7) adding curriculum specification details on the front cover.

Practicality and aesthetic appeal were confirmed through user response questionnaires. Student responses yielded a 92% practicality rating, while teacher evaluations reached 100%, placing the LKPD in the "highly practical" category. High user ratings reflected the worksheet's ease of use, visual appeal, and instructional clarity. Student enthusiasm, group participation, and task motivation during lessons further substantiated the creation of an active, enjoyable learning environment.

The effectiveness of the LKPD in fostering computational thinking skills was demonstrated through statistical analyses of pretest and posttest scores. Normality testing confirmed a normal distribution ($p > 0.05$). Subsequent paired-samples t -tests revealed a statistically significant difference in student performance before and after LKPD implementation ($p < 0.05$). The calculated normalized gain (N-gain) averaged 0.42, falling into the moderate improvement category. Furthermore, the effect size calculation yielded a Cohen's d value of 1.180, exceeding the high-effect threshold (> 0.8). These statistical indicators confirm that the problem-solving model-based LKPD is highly effective in enhancing computational thinking skills regarding fractions among fourth-grade students at SDN Sonokwijenan II.

Distinct pedagogical characteristics separate this study from prior research on elementary mathematics worksheets. While Ogunsola et al. (2021) developed Problem-Based Learning worksheets to improve student interest and achievement in three-dimensional geometry, the current study specifically targets fraction concepts integrated with explicit computational thinking frameworks. Similarly, while Fajrie (2022) developed interactive digital worksheets (E-LKPD) for mathematical literacy, this study focused on a systematically structured physical print worksheet optimized for elementary classroom dynamics.

Future instructional development in mathematics must move beyond traditional drill-and-practice exercises toward materials that facilitate independent concept discovery through systematic reasoning. The developed LKPD achieves this by training students to deconstruct problems, plan solution strategies, execute procedures, and evaluate outcomes. This aligns with Mulyasari (2022), who emphasized that problem-solving

activity design develops higher-order thinking skills and yields meaningful learning gains.

Theoretical and practical implications emerge from these findings. Theoretically, this study reinforces that structured problem-solving scaffolds deeper mathematical understanding by directing cognitive focus toward thinking mechanisms rather than rote computation. Practically, the developed LKPD offers elementary educators an innovative, contextually grounded resource that increases student agency and connects abstract fraction concepts to everyday applications.

Integrating problem-solving models in elementary mathematics elevates student participation and learning relevance. Emphasizing conceptual reasoning over mechanical calculations fosters critical thinking and logical reasoning (Salami & Spangenberg, 2025). Nevertheless, implementation constraints exist. Student readiness varies; learners with lower baseline skills require continued teacher guidance through the problem-solving stages. Additionally, systematic problem-solving, group discussions, and reflective evaluations require substantially more instructional time than traditional lecture methods, necessitating effective time management and scaffolding by educators.

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