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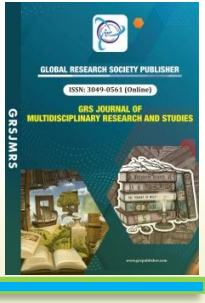
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The Effect of Computational Thinking Instruction on Mathematics Learning Outcomes in Plane Geometry in a Micro-Sized Classroom

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Abstract: Computational thinking (CT) is an important skill to develop in elementary mathematics learning, particularly in plane geometry, which requires conceptual understanding rather than mere memorization of formulas. This study examined the effect of an unplugged CT-based learning approach on fifth-grade students' mathematics learning outcomes in plane geometry in a micro-sized classroom. A quantitative approach using a one-group pretest–posttest design was employed with seven fifth-grade students at SD Negeri 2 Jatigreges, selected through total sampling. The learning activities incorporated four CT components—decomposition, pattern recognition, abstraction, and algorithms—through unplugged activities without computers. Data were analyzed descriptively and inferentially using a paired-samples t-test in JASP after the difference scores were found to meet the normality assumption based on the Shapiro–Wilk test. The mean score increased from 67.71 on the pretest to 82.00 on the posttest. The test yielded $t = -13.17$, $df = 6$, $p < 0.001$, indicating a statistically significant difference between pre- and post-instruction scores. Cohen's d was 4.977, indicating a very large effect size in the group studied. These findings suggest that unplugged CT instruction may improve mathematics learning outcomes in plane geometry in micro-sized classrooms. However, the findings should be interpreted cautiously because the sample was small and the study had no control group.

***Keywords**: Computational Thinking; Mathematics Learning Outcomes; Plane Geometry; Micro-Sized Classroom; Elementary School.*

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Introduction

The primary goal of mathematics education is not merely to teach students to calculate and memorize formulas, but also to develop their ability to understand concepts, reason, and solve problems in various situations. One topic requiring such understanding is basic two-dimensional geometry. It involves recognizing shapes, identifying their properties, understanding relationships among concepts, and applying area and perimeter formulas in everyday life. However, students' understanding of geometry remains a challenge in mathematics learning. Ismayanti et al. (2026) found that most students in their study could distinguish shapes and identify the properties of plane figures, but still struggled to explain relationships among shapes and provide logical explanations based on those properties.

Difficulties in understanding geometric concepts can affect students' performance on mathematics problems. Students who memorize area and perimeter formulas may not necessarily be able to choose an appropriate strategy when faced with problems presented in different forms or contexts. Instruction that focuses too heavily on procedures may lead students to concentrate on final answers without understanding the reasoning behind each solution step. This highlights the need for learning experiences that go beyond formula mastery and give students opportunities to develop logical, systematic, and reflective thinking.

Twenty-first-century educational challenges increasingly emphasize the importance of higher-order thinking skills. One relevant skill is computational thinking (CT), a structured approach to solving problems. In mathematics learning, CT can be implemented through four key components: decomposition, pattern recognition, abstraction, and algorithmic thinking. These components help students break complex problems into simpler parts, identify similarities and regularities, select relevant information, and organize solution steps systematically (Irawati & Hadi, 2025).

Integrating CT into mathematics instruction may help students understand concepts and strengthen their problem-solving skills. A review by Suparman et al. (2025), covering 43 empirical studies involving 7,807 students, found a significant positive effect of STEAM-based mathematics instruction on CT skills. The review

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also indicated that effectiveness may depend on intervention duration, the use of information and communication technology, and the mathematical content being taught. This suggests that CT implementation should be adapted to the content and learning context. Similarly, Megawati, Sholihah, and Limiansih (2023) integrated CT into fourth-grade mathematics instruction on fractions and reported a mean learning outcome of 83.7, 100% mastery, and positive student responses, supporting the potential of CT integration to improve elementary mathematics learning.

In elementary education, CT does not always require computers, programming, or digital applications. It can also be developed through unplugged activities, which cultivate computational thinking without computer devices. This approach enables teachers to integrate CT into mathematics through concrete, visual, and contextual learning tasks. Aprilia and Surayanah (2026) found that unplugged coding activities could improve elementary students' ability to solve geometry problems. Their activities incorporated algorithms, sequencing, pattern recognition, decomposition, and debugging. Although their study involved second-grade students, it illustrates how CT-based activities can support mathematical problem-solving from the early years of elementary school.

The application of CT in elementary mathematics has also been investigated among fifth-grade students. Marta et al. (2026) examined CT-based mathematics instruction in a quasi-experimental study involving 120 students from four parallel classes. The intervention developed problem decomposition, pattern recognition, abstraction, algorithmic reasoning, and debugging. Students who received CT-integrated instruction showed greater improvement in applying problem-solving strategies than the comparison group. However, the study focused on multistep word problems, including fractions and ratios, rather than plane geometry.

These studies leave room for further research connecting CT-based instruction with foundational geometry, particularly two-dimensional shapes in fifth grade. Classroom context is also important. For example, Pratiwi, Sastrawati, and Putri (2026) developed CT-based student worksheets for two-dimensional geometry and found them valid, practical, and effective in improving fifth-grade students' mathematical problem-solving. However, their study focused on instructional-material development using the ADDIE model rather than experimentally testing the effect of instruction in a small classroom. The present study addresses this gap by implementing unplugged CT in plane geometry in a micro-sized classroom. Such a classroom allows more intensive teacher guidance, closer observation of students' thinking, and instructional adjustments to individual needs. Nevertheless, the effectiveness of this approach for improving mathematics learning outcomes in plane geometry requires empirical examination.

In this study, CT was incorporated into three main activities: decomposing the properties of plane figures, identifying patterns in area and perimeter formulas, and organizing problem-solving steps algorithmically. CT was therefore not treated as an additional skill separate from mathematics, but was integrated directly into the learning process.

This study aimed to examine the effect of a CT-based learning approach on fifth-grade students' mathematics learning outcomes in plane geometry in a micro-sized classroom. The findings are expected to provide empirical information about the use of unplugged CT to support structured, meaningful mathematics learning suited to small-class settings.

Method

Research Design

This quantitative study used a quasi-experimental approach. Because Grade 5 at SD Negeri 2 Jatigreges consisted of only seven students, a one-group pretest–posttest design was used. All students completed a pretest to assess their initial ability, received CT-based mathematics instruction, and then completed a posttest to measure changes in learning outcomes.

The research design is illustrated as follows:

$O_1 – X – O_2$

Where:
O_1 = pretest;
X = CT-based instruction on plane geometry;
O_2 = posttest.

A similar design was used by Aprilia and Surayanah to investigate unplugged coding activities in geometry. However, findings from a single-group design without a comparison group must be interpreted cautiously because improvements cannot be fully separated from factors other than the intervention.

Population and Sample

The study was conducted with fifth-grade students at SD Negeri 2 Jatigreges. The participants comprised the entire Grade 5 population of seven students. Total sampling was used because the population was small; therefore, all seven students participated in the study.

Research Procedure

The study consisted of several stages. During preparation, the researchers developed a CT-based teaching module or lesson plan, prepared the test instrument, and designed learning activities on plane geometry. CT was implemented through four main components: decomposition, pattern recognition, abstraction, and algorithmic thinking. These components helped students analyze the properties of plane figures, identify patterns in area and perimeter formulas, and organize problem-solving steps systematically.

In the second stage, the seven students completed a pretest to establish their initial abilities. The third stage involved the intervention over several lessons. Unplugged activities included classifying the properties of plane figures, identifying patterns, sequencing solution steps, and checking answers. Finally, students completed a posttest containing questions equivalent to those in the pretest to assess changes in learning outcomes.

Research Instrument

The instrument was a written test consisting of 10 open-ended questions on plane geometry, including squares, rectangles, triangles, and composite plane figures. The questions assessed conceptual understanding, area and perimeter calculations, and problem-solving through CT processes. The instrument was reviewed by experts before use. Responses were scored using a prepared rubric to improve objectivity. This expert review is consistent with Novianto, Maknun, Aliyah, and Khalifah (2025), who developed a CT assessment instrument for elementary

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mathematics and emphasized the importance of instrument validity and reliability for accurate measurement of students' CT skills.

Data Analysis

The collected data were analyzed using descriptive and inferential statistics. Pretest and posttest scores were calculated using the following formula:

$$\bar{X} = \frac{\sum X}{N}$$

Learning gains were then analyzed using a paired-samples t-test in JASP. The basic calculation can be expressed as follows:

$$t = \frac{\bar{D}}{S_D/\sqrt{N}}$$

Here, the mean difference represents the average difference between posttest and pretest scores, the standard deviation represent the variability of the difference scores, and n represents the number of students. If the normality assumption is not met, the Wilcoxon signed-rank test may be used. JASP was used to verify the manual calculations, and the significance level was set at 0.05.

Results and Discussion

The study involved seven fifth-grade students at SD Negeri 2 Jatigreges and examined changes in mathematics learning outcomes after CT-based instruction on plane geometry. All students completed a pretest before the instruction and a posttest afterward.

Table 1. Students' Pretest and Posttest Scores

No.	Student Code	Pretest	Posttest	Gain
1	LAN	59	74	15
2	MF	75	85	10
3	MGA	73	87	14
4	NAW	57	76	19
5	NAP	68	82	14
6	SAA	66	82	16
7	MAM	76	88	12

As shown in Table 1, all students' scores increased after CT-based instruction. The mean pretest score was 67.71, while the mean posttest score increased to 82.00, representing an average gain of 14.29 points.

The largest gain was recorded by student NAW, whose score increased from 57 to 76, a gain of 19 points. The smallest gain was recorded by student MF, whose score increased from 75 to 85, a gain of 10 points. Student MGA's score increased from 73 to 87, a gain of 14 points. These results indicate that gains occurred not only among students with lower initial scores but also among those whose initial scores were relatively high.

Tabel 2 Deskripsi Statistik

	Pretest	Posttest
Valid	7	7
Missing	0	0
Mean (arithmetic)	67.71	82.00
Standard Deviation	7.566	5.323
Minimum	57.00	74.00
Maximum	76.00	88.00

As shown in Table 2, pretest scores ranged from 57 to 76, whereas posttest scores ranged from 74 to 88. In addition to the increase in the mean, score variability decreased. JASP results showed a pretest standard deviation of 7.566 and a posttest standard deviation of 5.323. The lower standard deviation suggests that students' scores were more closely clustered after the intervention.

Descriptively, CT-based instruction was associated with positive changes in learning outcomes. However, an increase in the mean alone is insufficient to establish statistical significance. Therefore, assumption checks and hypothesis testing were conducted using JASP.

Assumption Testing

Before testing the hypothesis, the researchers conducted a Shapiro–Wilk normality test to determine whether the difference scores between the pretest and posttest met the normality assumption required for the paired-samples t-test.

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Table 3. Shapiro–Wilk Normality Test Results

Test of Normality (Shapiro-Wilk)

			W	p
Pretest	-	Posttest	0.9804	.961

Note. Significant results suggest a deviation from normality.

As reported in Table 3, the Shapiro–Wilk statistic was W = 0.980, with p = 0.961. Because p was greater than 0.05, the difference scores did not show a statistically significant departure from a normal distribution. The normality assumption was therefore considered satisfied, and the analysis proceeded using the paired-samples t-test.

This result was consistent with the Assumption Checks output in JASP, which also reported a Shapiro–Wilk significance value of 0.961. Thus, the Wilcoxon test was not required as the primary analysis.

Hypothesis Testing

After the normality assumption was checked, the hypothesis was tested using a paired-samples t-test to determine whether students' learning outcomes differed before and after CT-based instruction.

Table 4. Paired-Samples t-Test Results

Paired Samples T-Test

Measure 1		Measure 2	t	df	p	Cohen's d	SE Cohen's d
Pretest	-	Posttest	-13.17	6	< .001	-4.977	0.3903

Note. Student's t-test.

As shown in Table 4, the test yielded t = −13.17, degrees of freedom (df) = 6, and p < 0.001. Since p was below 0.05, students' learning outcomes differed significantly before and after CT-based instruction.

The negative t value occurred because JASP calculated the difference as pretest minus posttest. Since posttest scores were higher than pretest scores, the resulting differences were negative. The negative sign therefore indicates the direction of the difference, not a negative instructional effect.

These findings support the descriptive results. The mean score increased by 14.29 points, from 67.71 on the pretest to 82.00 on the posttest. With p < 0.001, this difference was statistically significant for the seven students included in the study.

In addition to the significance test, JASP produced Cohen's d = −4.977. The negative sign can be disregarded when interpreting the magnitude of the effect because it reflects the pretest-minus-posttest calculation. The absolute effect size was therefore |d| = 4.977, indicating a very large effect in the group studied. This means that the score change was large relative to the variability of the students' change scores.

Nevertheless, the effect size must be interpreted in light of the study design. Only seven students participated, and the one-group pretest–posttest design had no control group. The results indicate a substantial change in this particular group, but they do not establish that the same outcome would occur in a larger student population.

Changes in Learning Outcomes Following Computational Thinking Instruction

The increase in the mean score from 67.71 to 82.00 indicates a positive change in students' achievement in plane geometry after the instruction. This change is more meaningful when considered in relation to the instructional approach: CT was not introduced as a separate subject, but was used as a way to help students solve mathematical problems.

Marta, Fadhilaturrahmi, and Wahyuni explain that CT can be integrated into elementary mathematics through problem decomposition, pattern recognition, abstraction, algorithmic reasoning, and debugging. In their study, these processes were intended to help students understand problem structures and apply solution strategies in different situations.

Their findings are relevant to the present study, although the context and outcome variables differ. Marta et al. involved 120 fifth-grade students across four classes and included intervention and comparison groups, whereas the present study involved seven students in one micro-sized class. The earlier study focused on transfer of problem-solving skills, particularly in word problems involving fractions and ratios. The present study specifically applied CT to plane geometry and examined mathematics learning outcomes.

This difference in context is important when interpreting the findings. In a class of only seven students, the teacher has more opportunities to observe each student's thinking. If a student struggles to select an area or perimeter formula, the teacher can identify the source of the difficulty more directly. This setting allows CT activities to be adapted more closely to individual needs.

The Role of Decomposition in Solving Plane Geometry Problems

An important CT component used in the instruction was decomposition, which involves breaking a complex problem into simpler parts. In plane geometry, decomposition is useful when a problem cannot be solved by recalling a single formula.

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For example, when working with composite plane figures, students were not immediately directed to find the final answer. Instead, they first identified the shapes in the diagram, determined the known measurements, selected the parts to calculate, and established the relationships among those parts. In this way, a seemingly complex problem could be broken down into manageable steps.

This approach differs from instruction that emphasizes formula memorization. Students must not only know that the area of a rectangle is length multiplied by width, but also understand when to use the formula, which information is needed, and how to apply it to the problem context.

Marta et al. found that CT-integrated mathematics instruction helped students organize their thinking through decomposition, pattern recognition, abstraction, algorithmic thinking, and debugging. They also emphasized that implementation quality influences the strength of an intervention's outcomes.

In a micro-sized classroom, decomposition can be developed through direct interaction. Teachers can ask students to explain the first step they intend to take and why they chose it before moving to the next step. Such interaction helps identify errors early and correct them before they affect subsequent steps.

The importance of decomposition was also reported by Suwarno, Habibah, Rahmadhani, Ramadhani, and Kurniawati (2026), who studied elementary students solving open-ended plane geometry problems. Of the four CT indicators examined, decomposition was the indicator students had the greatest difficulty demonstrating optimally, whereas algorithmic thinking was the easiest. This finding reinforces the need for explicit decomposition practice so students learn to identify relevant information before developing a solution strategy.

The Role of Pattern Recognition in Plane Geometry

Another CT component is pattern recognition. In plane geometry, recognizing patterns can help students understand similarities and differences among the properties of shapes.

Students can be guided to examine the number of sides, side lengths, angles, and relationships among measurements in squares, rectangles, and triangles. Through these activities, students move beyond memorizing shape names and begin to recognize patterns relevant to calculating area and perimeter.

Pattern recognition is also useful when students encounter problems that look different but rely on the same mathematical concept. For example, problems may use different contexts but ultimately ask students to calculate the area of a rectangle. Recognizing this pattern helps students understand that a change in context does not necessarily mean a change in the underlying concept.

This point is consistent with the literature reviewed in the cited sources.

A review published in AL JABAR: Jurnal Pendidikan dan Pembelajaran Matematika reported that CT integration in mathematics is associated with systematic thinking, problem-solving, higher-order thinking, learning engagement, and mathematics performance. The review also identified decomposition, pattern recognition, abstraction, and algorithmic thinking as key CT components.

These findings support the instructional approach used in this study. Rather than memorizing each problem as a separate task, students were encouraged to identify the underlying structure shared by different problems. Formula understanding may therefore become more meaningful because students can connect shape properties and the information provided with the formula selected.

The Role of Algorithmic Thinking in Solving Open-Ended Questions

Algorithmic thinking is closely related to the format of the instrument used in this study. Because the instrument consisted of open-ended questions, students were expected to show an ordered solution process rather than provide only a final answer.

Algorithmic thinking was practiced by having students organize solution steps: identify the given information, determine what is being asked, select a formula, substitute the data, perform the calculations, and check the result.

This routine helps students understand that mathematical problem-solving is a process. If the final answer is incorrect, students and teachers can trace the steps to identify where the error occurred.

Aprilia and Surayanah's study of unplugged coding in geometry also incorporated algorithms, sequencing, pattern recognition, and decomposition. They reported improved problem-solving after the activities, particularly in understanding problems and carrying out plans.

The present study is similar in its use of CT activities that do not depend on computers. The studies differ in grade level and content: Aprilia and Surayanah studied 24 second-grade students' geometry problem-solving, whereas the present study involved seven fifth-grade students and focused on learning outcomes in plane geometry.

Notably, Aprilia and Surayanah also found that reviewing the solution at the end showed the smallest improvement.

Similar evidence for unplugged activities to develop algorithmic thinking was reported by Apriadi, Majid, and Karlimah (2025), who used a "Robot Constructor" activity for cubes and rectangular prisms in Grade 6. Students who initially gave incomplete or unordered instructions were able to produce more logical and efficient steps after reflection and revision. This supports the view that algorithmic thinking in geometry should be developed gradually through concrete activities.

They recommended strengthening strategy planning, self-checking, reflection, debugging, abstraction, and decomposition so that students learn not only to follow procedures but also to evaluate and improve their results.

These findings provide a useful point for reflection. Although posttest scores increased, this does not automatically demonstrate that all CT components developed to the same extent. The instrument primarily measured mathematics learning outcomes. Additional instruments, such as observation sheets or rubrics assessing decomposition, pattern recognition, abstraction, algorithms, and debugging separately, would be needed to examine each CT component more specifically.

Consistency with Previous Studies

Overall, the findings are consistent with several studies in the reviewed literature. First, Marta et al. found that CT integration in

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elementary mathematics produced greater improvement in problem-solving transfer than regular instruction. Their study involved fifth-grade students and used decomposition, pattern recognition, abstraction, algorithmic reasoning, and debugging.

The studies are similar in grade level and in using CT as an approach to mathematics instruction. They differ in design and context. Marta et al. used a nonequivalent-groups pretest–posttest design with 120 students, whereas the present study used a one-group pretest–posttest design with seven students because of the micro-sized classroom context. The present findings should therefore be viewed as preliminary evidence of changes in learning outcomes in a small class, rather than generalized to all elementary students.

Second, Aprilia and Surayanah showed that unplugged coding activities can be used in geometry instruction without computer devices.

Their study used a one-group pretest–posttest design and reported a difference between scores before and after the intervention. However, the authors noted that a design without a control group cannot establish with certainty that the observed change resulted entirely from the intervention.

This design is relevant to the present study because both studies used one group and measured change before and after an intervention. The present study differs by applying CT activities directly to fifth-grade plane geometry in a class of seven students. This context distinguishes it from the earlier study.

Third, a literature review in AL JABAR: Jurnal Pendidikan dan Pembelajaran Matematika reported that CT integration in mathematics may benefit problem-solving, higher-order thinking, learning engagement, and mathematics performance.

The review also emphasized the close relationship between CT and mathematical thinking, as both require logical and systematic reasoning, analysis, and the development of solution strategies.

Fourth, the effectiveness of computer-free CT activities is supported by Syamsiah, Firmansyah, Mustika, Burhanudin, Gani, and Fitriani (2024), who implemented unplugged coding education based on local wisdom alongside coding robots for elementary-aged children and reported a significant increase in Bebras test scores (asymp. sig. < 0.05), from a mean of 55.1 to 89.5. Afifah et al. (2025) likewise reported significant pretest–posttest differences following unplugged activities among second-grade students in a setting with limited access to technology; the gain was moderate and the intervention was considered reasonably effective. In addition, Permadani, Pangestu, Abung, and Destini (2026) found that CT-based mathematics instruction contributed 52.4% to fourth-grade students' critical-thinking skills according to a simple linear regression analysis. These studies support the potential of unplugged CT in elementary education, although micro-sized classrooms were not the main focus of those studies.

The findings from SD Negeri 2 Jatigreges follow a similar pattern. Mean learning outcomes increased by 14.29 points after CT-based instruction. The present study is more specific because it took place in a micro-sized classroom. With only seven students, teacher–student interactions could be more intensive, allowing the teacher to ask guiding questions, observe students' work, provide immediate feedback, and tailor support to individual difficulties.

Interpreting the Findings in a Micro-Sized Classroom

The findings should be understood in relation to the characteristics of the classroom in which the study took place. A class of seven students differs from a regular class with a larger enrolment. In a micro-sized class, students have more opportunities to explain their thinking, ask questions, justify their reasoning, and receive direct feedback.

This setting may support CT because students are expected not only to produce an answer but also to explain how they arrived at it. While solving plane geometry problems, teachers can ask students why they selected a particular formula, how they separated the information in the problem, and how they organized their solution steps.

Marta et al. emphasized that CT should not be assumed to work automatically simply because CT components are included in instruction. Implementation quality, or instructional fidelity, is also an important factor influencing the strength of an intervention.

This is particularly important in a micro-sized classroom. A small number of students creates opportunities for more intensive interaction, but learning success still depends on how each CT stage is implemented. If teachers only ask students to follow prescribed steps without allowing them to explain their reasoning, identify patterns, or check errors, CT may become another rote procedure.

Thus, the increase in the mean score from 67.71 to 82.00 can be viewed as an indication that the instructional approach was associated with improved learning outcomes in plane geometry. However, this conclusion must remain limited to the seven students who participated in the study.

Study Limitations

Several limitations should be noted. First, the study included only seven students. This reflects the micro-sized classroom at SD Negeri 2 Jatigreges, but it also limits the extent to which the findings can be generalized.

Second, the study used a one-group pretest–posttest design without a control group. Therefore, the score increase cannot be attributed solely to CT instruction with certainty. Other factors, including learning experiences during the study, practice, instructional time, and individual student characteristics, may also have contributed.

This limitation is consistent with the caution raised in Aprilia and Surayanah's study.

Those authors noted that findings from a single-group design without a control group should be interpreted carefully and validated through research using a stronger experimental design.

Third, the primary instrument was a learning-outcome test. Consequently, the study mainly documented changes in mathematics scores and did not measure the development of each CT component using a separate instrument. Future studies could add observation sheets or interviews to examine how students decompose problems, recognize patterns, abstract relevant information, develop algorithms, and debug errors.

Overall, the data indicate improved mathematics learning outcomes after CT-based instruction. The mean score increased from 67.71 to 82.00, all students improved, and the paired-samples t-test indicated a statistically significant difference. These findings suggest that CT can be used to teach plane geometry in a micro-sized classroom. They also indicate that instruction emphasizing

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thinking processes, rather than formula use alone, may help students solve mathematical problems more systematically.

However, these results should not be interpreted as proof that CT will necessarily improve outcomes in every instructional context. They are best understood as empirical evidence from a specific setting: Grade 5 mathematics instruction involving seven students at SD Negeri 2 Jatigreges. This context is also a contribution of the study, as micro-sized classrooms have not been a central focus in the CT studies used for comparison.

Conclusion and Recommendations

Conclusion

Based on the findings and analysis, the hypothesis that CT-based instruction can improve mathematics learning outcomes was supported for the group studied. The class mean increased from 67.71 on the pretest to 82.00 on the posttest. The paired-samples t-test indicated a statistically significant difference ($t = -13.17$, $p < 0.001$), with a very large effect size (Cohen's $d = 4.977$). In practice, CT processes—decomposition, pattern recognition, abstraction, and algorithmic thinking—helped students approach plane geometry in a more systematic and structured way. Nevertheless, the study was limited to seven participants and had no control group. The findings cannot be generalized broadly and should be viewed as evidence of change within this specific small group.

Recommendations

Based on the findings and limitations, teachers working in small classes may consider using unplugged CT in mathematics, particularly in geometry. Activities can be adapted to students' needs through problem decomposition, pattern finding, sequencing solution steps, and checking answers without relying on computer devices.

Future research should involve a larger sample and a comparison group so that the effects of CT-based instruction can be examined using a stronger research design. Further studies could also investigate CT's effects on critical thinking, problem-solving, and computational thinking skills. Unplugged CT could additionally be applied to other geometry topics to explore its use across different learning contexts.

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