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The Effect of Direct Instructions Strategy Integrated Computational Thinking and Prior Knowledge on Critical Thinking and Problem-solving

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Abstract

In the current digital era, critical thinking and problem-solving skills are becoming increasingly important in everyday life, especially in the industrial era 4.0. One way to develop this ability is to use computational Thinking methods (CT). This research aims to test the effect of direct instruction strategy, integrated computational thinking, and prior knowledge on elementary schools' critical thinking and problem-solving skills in Heat and Changes in Science. The method used in this research is a quasi-experimental pretest-posttest non-equivalent control group design. This research was conducted at Madrasah Ibtidyah Ar-Rahmah Samarinda, involving 58 research subjects. The research instrument includes a prior knowledge test and critical thinking and problem-solving skills. To test the prerequisites for analysis using the normality test and homogeneity. Data analysis was used to test the research hypothesis using parametric statistics Tow Way MANOVA analysis technique. The research results show that (1) There are significant differences in critical thinking skills between groups of students who use computational learning and direct learning methods instructions; (2) critical thinking skills between groups of students with high prior knowledge are significantly from low prior knowledge; (3) There is no interaction between computational thinking and prior knowledge on students' critical thinking skills; (4) There are significant differences in problem-solving skills between groups of students who use computational learning and direct learning instructions; (5) The problem-solving skills of students with high prior knowledge is significantly different with low prior knowledge; (6) There is interaction between computational thinking and prior knowledge on students' problem-solving skills.

Keywords: Direct Instruction, Computational Thinking, Prior Knowledge, Problem-Solving

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INTRODUCTION

In the 21st century, students must have skills that can make them successful. Essential skills in the 21st century that relate to the four pillars of life, namely: to know, to do, to be, and to live. These four principles include specific skills that must be strengthened in learning activities: critical thinking, problem-solving, metacognition, communication, collaboration, innovation and creation, information literacy, and many other skills (Aliftika et al., 2019).

Van Laar et al. (2020) stated that critical thinking and problem-solving skills are essential for developing 21st-century citizenship. Problem-solving skills are very much needed to develop students' abilities. Problem-solving combines various concepts, rules, or formulas to solve a problem (Dörner & Funke, 2017). According to Greenstein (2012), the steps in solving problems are formulating the problem, brainstorming, drawing up a plan, implementing the plan, and evaluating the results.

Problem-solving is an essential ability students need (Chamidy et al., 2020). Problem-solving skills encourage students to make correct, careful, methodical, logical, and well-thought-out decisions from various perspectives (Güner & Erbay, 2021). Problem-solving skills enable students to use higher-order thinking skills (Sagala & Andriani, 2019). Higher-order thinking skills can help students face daily challenges (Darmayanti et al., 2022; Sepriyanti et al., 2022). Higher-order thinking skills have several components, including critical and creative thinking abilities (Nurhatmanti et al., 2021).

Critical thinking skills are part of logical and systematic thinking skills. Critical thinking skills are needed for college graduates to work (Al-Zou'bi, 2021). However, the fact is that students' critical thinking in Indonesia is still relatively low (Ramadhani* et al., 2023; Saphira & Prahani, 2022). One of the reasons for the low critical thinking skills is based on students' worksheets who can express the results of arguments in their assignment sheets because their knowledge is limited in critical thinking concepts and approaches (Depari et al., 2021).

Effective learning emphasizes learning as a personal process where students accumulate knowledge and experience (Darling-Hammond et al., 2020)). Each student gathers personal knowledge and experience by interacting with their environment. Learning is seen as constructing knowledge from concrete experiences and collaborative, reflective, and interpretive activities (Holmes et al., 2022). Education is a learning process where students receive and understand knowledge as part of themselves. In the learning process, students not only hear the teacher deliver the material and write it down during the exam but must be actively involved in the learning process.

The choice of learning methods must be made carefully so that student learning outcomes are the determined learning outcomes. In addition, different prior knowledge will cause teachers to vary their material delivery so that all students achieve competence and develop higher reasoning abilities and an independent attitude. One of the abilities humans need in the 21st century is thinking critically and solving increasingly large and complex problems with computational thinking strategies.

A computational thinking approach is needed, considering that problem-solving skills are required to solve life's problems. Computational thinking does not have to be associated with computers, but humans must also be able to think computationally (Aranda & Ferguson, 2022). Therefore, computational thinking is a process that involves formulating problems and expressing solutions so that computers (human or machine) can work effectively. Computational implementation thinking can be incorporated into several tasks related to material analysis, identifying questions that can be answered based on knowledge of a given problem. Sometimes, too much or too little information is collected. Therefore, students learn to recognize patterns to obtain accurate information. In addition, students understand that data representation is significant in solving the problems they face (Chan, 2020). Computational thinking can be practiced in elementary school subjects, such as science.

A study by John Lemay et al. (2021) argues that computational thinking is a new way to solve problems. His research is supported by (Limbong et al., 2023), who explains that computational thinking applies broad strategies to solve complex problems. Algorithmic thinking, decomposition, abstraction, and logic are the foundations of computational thinking that can guide students in solving complex problems. Thus, his research can conclude that applying computational thinking can improve students' critical thinking (Kawuri et al., 2019). Other research conducted by (Angraini et al., 2022) shows increased learning outcomes using computational thinking methods. This indicates that the computational thinking method significantly influences students' thinking abilities, especially in solving algorithm problems (Huang & Looi, 2021).

Based on the problems above, researchers are interested in studying and analyzing the influence of computational thinking methods and prior knowledge on critical thinking and problem-solving skills.

METHODS

The approach used in this study is quantitative. Because this kind of research aims to measure the influence of Direct Instruction strategies and initial abilities on two dependent variables: critical thinking skills and problem solving. The quantitative approach in this study allows researchers to objectively measure the results of the application of learning strategies and integration of computational thinking. Analyzing numerical data using statistical techniques to see the relationship and influence between variables and conducting hypothesis tests to determine whether Direct Instruction strategies and initial abilities have a significant effect on critical thinking skills and problem solving.

The research design used was a quasi-experimental non-equivalent control group. The research population was all fifth-grade students at Madrasah Ibtidaiyah Ar-Rahmah, with the sample determined using a purposive random sampling technique, namely determining classes based on considering the abilities of the same students. Based on the technique, it was found that the VA class was a control class with Direct Instruction learning, and the VB class was an experimental class with direct instructional and computational thinking.

Independent variables cause or influence, namely factors that researchers measure, manipulate, or select to determine the relationship between observed phenomena (Tuckman, 1999). The independent variable is two learning strategies: direct and moderator variables, which are high and low prior knowledge. Meanwhile, the dependent variable is critical thinking and problem-solving skills.

The collection technique used is a test. The test is used to measure problem-solving skills before and after treatment, and it was developed based on problem-solving indicators, according to Polya. This test is a partial essay, or each question represents an indicator of problem-solving. The research technique is a multivariate analysis of variance (Manova), which is two paths. According to Tuckman (1999), variance analysis allows researchers to determine the simultaneous influence of several independent variables.

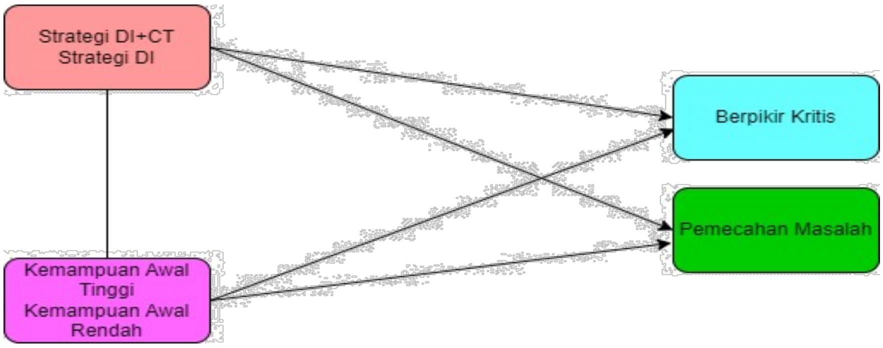

Figure 1. Conceptual Relationships Between Research Variables

RESULTS & DISCUSSION

Normality and Homogeneity Test

Refer to Table 1. The results of calculating the probability value of the Test of Normality Kolmogorov-Smirnov can be summed up as follows:

The Kolmogorove-Smirnov test shows that students' critical thinking scores and problem-solving skills in the group of students taught using computational methods, thinking, direct attraction, and high and low prior knowledge indicate that the probability is > 0.05. This shows that both data are normally distributed.

Table 1. Normality Test Results for Critical Thinking and Problem-Solving Scores Based on Learning Methods.

Tests of Normality							
	Learning methods	Kolmogorov-Smirnov a			Shapiro-Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
Critical Thinking	Computational Thinking	.116	29	.200*	.961	29	.352
	Direct Instruction	.131	29	.200*	.973	29	.635
Problem-solving	Computational Thinking	.102	29	.200*	.970	29	.569
	Direct Instruction	.150	29	.096	.943	29	.119
Critical Thinking	High	.119	38	.196	.973	38	.481
	Low	.150	20	.200*	.979	20	.915
Problem-solving	High	.100	38	.200*	.967	38	.310
	Low	.133	20	.200*	.943	20	.268

The homogeneity test is applied to obtain similarities in data variables. The homogeneity test uses Levene's test Statistics with a significance level of 0.05, with the help of SPSS, which is displayed in Table 2:

Table 2. Data Homogeneity Test in Critical Thinking and Problem-Solving Results

Test of Homogeneity of Variance					
		Levene Statistics	df1	df2	Sig.
Critical Thinking	Based on Mean	1.087	1	56	.302
	Based on Median	.889	1	56	.350

	Based on Median and with adjusted df	.889	1	55.088	.350
	Based on trimmed mean	1.015	1	56	.318
Problem-solving	Based on Mean	.374	1	56	.543
	Based on Median	.380	1	56	.540
	Based on Median and with adjusted df	.380	1	55.204	.540
	Based on trimmed mean	.386	1	56	.537

The same results were conducted to determine the homogeneity of data resulting from critical thinking and problem-solving based on prior knowledge by referring to columns based on the mean. The homogeneity test results in Table 2 show that the probability value achieved from the calculation results is greater than the probability value α = 0.05, namely 0.406 for critical thinking and 0.261 for problem-solving. This means that H0 is accepted, so it can be concluded that the data variations are homogeneous.

It was based on the results of class V students' problem-solving skills test at Madrasah Ibtidaiyah Ar-Rahmah, which is as follows:

Table 3. Students' Initial Critical Thinking and Problem-Solving skills

Variables	Direct Instructions	Prior Knowledge	Mean	Std. Deviation
Critical Thinking	Computational Thinking	High	83.40	8,666
		Low	78.56	6,227
		Total	81.90	8,209
	Direct Instruction	High	79.28	5,949
		Low	73.73	7,295
		Total	77.17	6,929
	Total	High	81.45	7,692
		Low	75.90	7,100
		Total	81.48	7,892
Problem-solving	Direct Instruction + Computational Thinking	High	80.00	8,189
		Low	78.56	7,732
		Total	79.55	7,940
	Direct Instruction	High	79.33	7,096
		Low	68.64	7,775
		Total	75.28	8,948
	Total	High	79.68	7,595
		Low	73.10	9,090
		Total	77.41	8,657

Referring to Table 3 above, it is evident that overall, a high prior knowledge of 82.12 has a higher problem-solving average than a low prior knowledge of 80.97, both from the aspect of the Direct Instruction+Computational Thinking strategy or direct attraction strategy and the overall total. Regarding the Direct Instruction+Computational Thinking strategy, 79.55 has higher average problem-solving skills than the direct abstraction method, 75.28.

After knowing the results of the prerequisite tests that have been described previously, namely normality and homogeneity of critical thinking and problem-solving data, as well as equality of the pre-test or initial test between the treatment and control groups, then testing of the critical thinking and problem-solving data can be carried out between the treatment and control data groups. The comparison was carried out using the MANOVA Multivariate Selection analysis. This variance is based on the number of variables in this research: two independent variables (Learning Method and Prior Knowledge) and two dependent variables (Critical thinking and problem-solving).

Table 4. Multivariate Analysis Results Tests

Multivariate Tests [a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.994	4462.981b	2.000	53.000	.000
	Wilks ' Lambda	.006	4462.981b	2.000	53.000	.000
	Hotelling's Trace	168.414	4462.981b	2.000	53.000	.000
	Roy's Largest Root	168.414	4462.981b	2.000	53.000	.000
Method* Prior knowledge	Pillai's Trace	.082	2.352 b	2.000	53.000	.105
	Wilks ' Lambda	.918	2.352 b	2.000	53.000	.105
	Hotelling's Trace	.089	2.352 b	2.000	53.000	.105
	Roy's Largest Root	.089	2.352 b	2.000	53.000	.105
Method	Pillai's Trace	.142	4.396 b	2.000	53.000	.017
	Wilks ' Lambda	.858	4.396 b	2.000	53.000	.017
	Hotelling's Trace	.116	4.396 b	2.000	53.000	.017
	Roy's Largest Root	.116	4.396 b	2.000	53.000	.017
Prior Knowledge	Pillai's Trace	.181	5.845 b	2.000	53.000	.005
	Wilks ' Lambda	.819	5.845 b	2.000	53.000	.005
	Hotelling's Trace	.221	5.845 b	2.000	53.000	.005
	Roy's Largest Root	.221	5.845 b	2.000	53.000	.005

Table 5. Tests Of Between-Subjects Effects

Tests of Between-Subjects Effects						
Source	Dependent Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Critical Thinking	226.539	3	4.261	4.261	.009
	Problem-Solving	353.100	3	353.100	5.935	.001
Intercept	Critical Thinking	322522.764	1	322522.764	6066.649	.000
	Problem-Solving	305478.335	1	305478.335	5134.461	.000
Method* Prior knowledge	Critical Thinking	1.621	1	1.621	.030	.862
	Problem-Solving	278.335	1	278.335	4.678	.035
Method	Critical Thinking	260.461	1	260.461	4.899	.031
	Problem-Solving	364.334	1	364.334	6.124	.017
Prior Knowledge	Critical Thinking	351.312	1	351.312	6.608	.013
	Problem-Solving	479.277	1	479.277	8.056	.006
Error	Critical Thinking	2870.815	54	53.163		
	Problem-Solving	3212.768	54	59.496		
Total	Critical Thinking	370443.000	58			
	Problem-Solving	351860.000	58			

Tests of Between-Subjects Effects						
Source	**Dependent Variables**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Total	Critical Thinking	3550.431	57			
	Problem-Solving	4272.069	57			

Referring to the results of data calculations on students' critical thinking skills as shown in Table 5, test results of between-subjects, The obtained effects price is F = 4.899 with P = 0.031 < 0.05 = α. Thus, H_0 is rejected, and it can be concluded that there is a significant difference in the critical thinking skills of groups of students who use computational learning methods thinking with direct instruction.

The second hypothesis test was also carried out, as shown in Table 4.9. Based on the test results, it is known that the F-score = 0.608 with P = 0.013 <0.05 = α. Then H_0 is rejected, and H_1 is accepted. This means a significant difference in critical thinking skills in science subjects on Heat and Transfer material between students with high and low prior knowledge.

Table 5 shows that the calculated F-value is (F = 0.030 with P = 0.862 > 0.05 = α), so H_0 is accepted, and H_1 is rejected. So, it can be stated that there is no interaction between computational learning methods, thinking, direct instruction, and prior knowledge toward critical thinking skills in science subjects on heat and transfer material.

As the calculation results have been obtained in Table 5 Tests of Between-Subjects Effects, It was concluded that there was a significant difference in influence between computational learning methods thinking with the direct method Instruction on student problem-solving learning outcomes with value (F 8.056 with P-value = 0.006 < 0.05 = α) thus there is a significant difference in problem-solving learning outcomes for students who study using computational methods thinking and groups of students who study using the direct method instruction.

The fifth hypothesis shows that there is a difference in influence between students who have prior knowledge of problem-solving learning outcomes with a value of F = 8.056 and a P value = 0.006 < 0.05 = α, so it is concluded that there is a significant difference in problem-solving learning outcomes between students who have high and low prior knowledge.

Sixth hypothesis Based on Table 4.8, it is known that the calculated F-value is (F = 4.678 with P = 0.035 < 0.05 = α) so that H_1 is accepted and H_0 is rejected. So, it can be stated that there is an interaction between learning methods, computational thinking, and direct interaction with prior knowledge of problem-solving skills in science subjects on heat and transfer material.

DISCUSSION

1. Direct Strategy Instruction that integrates Computational Direct Thinking and Strategy Instruction on Students' Critical thinking skills

The results of hypothesis testing regarding the influence of learning methods on students' critical thinking skills showed significant differences in the critical thinking skills of groups of students who studied using computational thinking methods with groups of students who studied using the direct method instruction.

Critical thinking involves understanding skills and applying the principles of logic and analysis in solving problems and evaluating and testing hypothetical assumptions objectively. In the educational context, critical thinking skills are often considered essential for developing academic abilities and a successful career.

Critical thinking skills is a skill method or process possessed by intelligent humans, which is used to solve problems encountered in life so that each individual can get answers to their problems. According to Bandura (2017) learning and thinking also appear in the context of beliefs about cognition, which is a process that varies as a function of personal, social, and cultural factors.

Learning using computational thinking methods can help improve students' critical thinking skills better than learning using direct methods of instruction (John Lemay et al., 2021). This research was conducted on junior high school students in Singapore who were divided into the CT and DI groups. The results show that students who learn using the CT method have a more significant increase in critical thinking skills than those who learn using the DI method.

However, the results of other studies do not always show significant differences in students' critical thinking skills between CT and DI methods. For example, research by Şahin Gökçearslan et al. (2018) on upper-secondary students in Turkey showed that both learning methods had the same impact on improving students' critical thinking skills.

Research results (Liu & Pásztor, 2022) show that computational-based learning positively influences students' critical thinking skills. Likewise, research (Montuori et al., 2023) shows that computational-based learning can improve students' critical thinking skills.

The results indicated significant differences in critical thinking skills between students who used computational thinking (CT) methods and those who used direct instruction (DI). Critical thinking is essential in education for problem-solving and involves applying logic and analysis. According to Bandura, learning and thinking vary based on personal, social, and cultural factors. Research shows CT methods improve critical thinking more effectively than DI, particularly in junior high students in Singapore. However, other studies, like those in Turkey, found no significant differences. Overall, computational-based learning tends to positively impact critical thinking skills.

2. Direct Strategy Instruction that integrates Computational Direct Thinking and Strategy Instruction on Problem-solving

Computational Computational thinking is an approach to solving problems using principles inspired by how computers work. Some principles related to computing thinking are dividing problems into small parts that are easier to solve, using patterns or algorithms to solve problems, and finding the most efficient and effective solutions.

Computational thinking methods can improve critical thinking skills because they require systematic and logical thinking in solving problems. Using computational methods thinking, one must divide the problem into smaller, easier-to-solve parts and then develop an algorithm or strategy to solve each part. This requires in-depth analytical and logical thinking skills to consider various factors related to the problem.

Apart from that, using computational thinking methods, one must also be able to test solutions and evaluate the results critically. This requires considering various alternatives and selecting the most appropriate solution based on specific criteria. Thus, computational thinking methods can help someone develop better critical thinking skills in solving problems.

Research conducted by Limbong et al. (2023) shows that students' problem-solving skills are better taught using computational thinking than direct instruction. This can be seen from the test results, which show that students who are taught using computational thinking methods can solve problems more quickly and accurately.

Research Arık (2022) shows that students with computational thinking methods have better problem-solving skills than those taught with direct instruction. This can be seen from the test results, which show that students who are taught using computational thinking methods can produce more creative and effective solutions. Likewise, Angraini et al. (2022) show that students taught using computational thinking methods have better problem-solving skills than those taught using direct instruction. This can be seen from the test results, which show that students are taught using computational methods, thinking can solve problems more quickly and accurately.

Computational thinking is a problem-solving approach inspired by how computers work, involving breaking down problems, using patterns or algorithms, and finding efficient solutions. The students taught with computational thinking methods develop better problem-solving skills, solving problems more creatively, quickly, and accurately compared to those taught through direct instruction. Overall, computational thinking leads to improved critical thinking and problem-solving abilities.

3. The Influence of High and Low Prior Knowledge on Critical Thinking Skills

There are differences in the critical thinking skills of students who study with high and low prior knowledge. The critical thinking skills of students with high prior knowledge are superior to those with low prior knowledge.

Research conducted by Valls Pou et al. (2022) evaluates the effectiveness of computational teaching thinking in improving students' critical thinking skills, especially students with low prior knowledge. The research results from Kania et al. (2023) stated that prior knowledge influences students' critical thinking skills; students with high prior knowledge can get better final grades.

Critical thinking skills are an essential aspect of education that must be developed to face the challenges of the 21st century (Thornhill-Miller et al., 2023). In everyday life, critical thinking is used to make decisions, form opinions based on reason, overcome individualistic assertions and predispositions and draw conclusions (Bekteshi, 2017).

Critical thinking skills have several roles or benefits in learning; namely, students become independent learners (Astutik & Wijayanti, 2020), students can solve problems (Tang et al., 2020), students can access various other information from various sources that are not only limited to books and analyze information using various basic knowledge from formal teaching materials, used to understand concepts, apply, synthesize, and to evaluate information obtained or information produced, activating the ability to analyze and evaluate evidence, identify questions, logical conclusions, and understand the implications of arguments, develop high-level intellectual abilities, foster the ability to observe, analyze, reasoning, decision making, and persuasion (Lukitasari et al., 2021).

Students with high prior knowledge have superior critical thinking skills compared to those with low prior knowledge. The computational thinking is particularly effective for students with low prior knowledge. The prior knowledge significantly influences critical thinking development. Critical thinking is essential in education and daily life for decision-making, reasoning, and overcoming biases. It fosters independent learning, problem-solving, information analysis, and the development of intellectual abilities, such as reasoning, decision-making, and persuasion.

4. The Influence of High Prior Knowledge and Low Prior Knowledge on Problem-Solving Learning Outcomes

Initial or prior capabilities Knowledge is a person's knowledge, skills, and understanding before learning a new concept or skill. Prior knowledge can be knowledge that has been mastered previously, either formally or informally, or experience that has been experienced previously.

Prior knowledge can influence a person's learning outcomes in a subject or skill. If a person has solid prior knowledge of a concept or skill, then he or she may more easily understand and master related new material. However, if a person has a weak or low prior knowledge of a concept or skill, he or she may experience difficulty understanding and mastering new related material.

Prior knowledge is essential in learning outcomes only if the content or information organized into knowledge comes from suitable sources. This is for students to understand new information or knowledge based on previous knowledge. Explanation of information can be a basis for someone to build new concepts. Prior knowledge can facilitate new learning by testing the relevance and accuracy of a new initial task (Alreshidi, 2023).

Prior knowledge refers to a person's existing knowledge, skills, or experiences before learning a new concept. It can significantly impact learning outcomes; individuals with strong prior knowledge grasp new material more easily, while those with weak prior knowledge may struggle. Prior knowledge is effective in supporting learning when it is organized and derived from appropriate sources, enabling students to build new concepts and understand new information based on what they already know. It also helps in assessing the relevance and accuracy of new tasks.

5. The Interaction Effect of Learning Strategies and Prior Knowledge on Critical Thinking Skills

Prior knowledge can influence a student's learning outcomes in a subject or skill. If a person has solid prior knowledge of a concept or skill, then he or she may more easily understand and master related new material. However, if a person has a weak or low prior knowledge of a concept or skill, he or she may experience difficulty understanding and mastering new related material.

Prior knowledge is essential in learning outcomes only if the content or information organized into knowledge comes from suitable sources (Widyaningsih & Sulisworo, 2023). This is for students to understand new information or knowledge based on previous knowledge. Explanation of information can be a basis for someone to build new concepts. Prior knowledge can help facilitate new learning by testing the relevance and accuracy of a new initial task (Alreshidi, 2023).

Therefore, educators need to pay attention to students' prior knowledge before starting learning so that learning can be adjusted to students' needs and abilities. Learning tailored to students' prior knowledge can improve students' thinking abilities, motivation, interests, and overall learning outcomes.

Prior knowledge significantly influences learning outcomes. Students with strong prior knowledge more easily grasp new material, while those with weak prior knowledge may struggle. Prior knowledge is crucial when it comes from suitable sources, helping students build new concepts and understand new information. It also aids in evaluating the relevance and accuracy of new tasks. Educators should consider students' prior knowledge to tailor learning, which can enhance students' thinking skills, motivation, interests, and overall outcomes.

6. The Interaction Effect of Learning Strategies and Prior Knowledge on Problem-Solving

Learning uses computational methods of thinking (CT) to improve problem-solving skills because CT involves basic skills and concepts, such as problem decomposition, pattern recognition, abstraction, algorithms, and evaluation, that can be applied to solving complex problems. However, the interaction between learning using the CT method and students' prior knowledge can also influence problem-solving skills.

Interaction between learning using computational thinking methods and students' prior knowledge can be essential in improving students' problem-solving skills. Students with higher prior knowledge may easily understand and apply basic CT skills and concepts in solving problems. Meanwhile, students with lower prior knowledge may need more guidance, practice, and practical learning approaches.

Research conducted by (Limbong et al., 2023) shows that computational teaching thinking improves students' problem-solving skills, especially students who have low prior knowledge. From this research, it can be concluded that teaching using computational thinking methods can help improve students' abilities to solve problems in various subjects, especially students with low prior knowledge.

Some weaknesses in this study include a reliance on overly structured Direct Instruction, a lack of variety in more flexible teaching approaches, limitations in understanding and applying computational thinking, and student resistance to new methods that can impact critical thinking and problem-solving skills.

Limitations of this study include: results that are difficult to generalize due to variations in students' initial abilities and backgrounds; measuring instruments that may be incomplete in assessing critical thinking and problem-solving skills; the short duration of the study so that long-term impacts are difficult to observe; variations in student abilities that affect the results; and the success of the strategy depends on the teacher's competence in delivering the material.

CONCLUSION

The research results show that (1) There are significant differences in critical thinking skills between groups of students who use computational learning and direct learning methods instructions; (2) critical thinking skills between groups of students with high prior knowledge are significantly from low prior knowledge; (3) There is no interaction between computational thinking and prior knowledge on students' critical thinking skills; (4) There are significant differences in problem-solving skills between groups of students who use computational learning and direct learning instructions; (5) The problem-solving skills of students with high prior knowledge is significantly different with low prior knowledge; (6) There is interaction between computational thinking and prior knowledge on students' problem-solving skills.

Recommendations for this research include developing curricula that integrate Direct Instruction and computational thinking strategies with practical applications, improving teacher training to support the implementation of these strategies, and comparing learning methods to explore different effectiveness. In addition, it is recommended to develop comprehensive assessment tools, conduct longitudinal research to evaluate long-term impacts, and investigate factors that influence student engagement. Research across educational contexts is also needed to explore the consistency of results, while developing teaching materials through interdisciplinary collaboration to enrich the learning experience. With these recommendations, research is expected to make a significant contribution to understanding the influence of learning strategies on students' critical thinking and problem-solving skills.

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