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Analysis of Students' Computational Thinking Abilities Based on Self-esteem

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ABSTRACT

Computational Thinking (CT) skills are a fundamental 21st-century skill that is essential in solving mathematical problems, but its success is inseparable from affective factors such as Self-esteem. This research is important because there are still few in-depth qualitative studies that analyze the CT thinking process from the characteristics of Self-esteem. Restriction on categories only Self-esteemhigh and low (without medium category) are based on theory Rosenberg (1965). The purpose of this study is to describe the CT ability of students reviewed from Self-esteem high and low. The method used was qualitative exploratory with the subjects of four students of class IX C SMP Negeri 5 Tasikmalaya who were selected purposively (two with Self-esteem high and two with Self-esteem low) and able to meet all four CT indicators. Instruments include questionnaires Self-esteem Guttman scale, written tests on algebraic form stories, and semi-structured interview guidelines. Data collection was carried out through questionnaire distribution, CT tests, and in-depth interviews, while data analysis used the Miles & Huberman analysis framework (reduction, presentation, conclusion drawn) with triangulation techniques. The results showed that cognitively all subjects were able to meet all four CT indicators, but the tendency of their thought processes to differ qualitatively. Students with Self-esteem high tends to indicate a systematic, structured, and efficient thought process (for example, students tend to understand the problem immediately with confidence without difficulty simplifying algebra or tend to be more careful by double-checking). In contrast, students withSelf-esteemtend to be nervous, afraid of making mistakes, read questions repeatedly, and hesitating in determining patterns, and tend to panic at the beginning, forget formulas, and have time to ask friends. Implications, Self-esteemplays more role in shaping the quality of computational thinking experiences than simply determining the achievement of cognitive indicators.

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Introduction

In today's digital age, computational thinking skills (computational thinking) is increasingly recognized as an essential 21st-century fundamental skill in a variety of disciplines (Ogegbo & Ramnarain, 2023). Computational thinking is defined as the process of solving basic cognitive problems that facilitates reading, writing, and reasoning activities in the modern era (Demir et al., 2022). According to wing (2008) introduces this concept and asserts that every individual, not just a computer scientist, should be able to think computationally to solve complex problems in everyday life. The importance of incorporating computational concepts into the educational curriculum Nuvitalia et al. (2022). Then, this ability has been proven to contribute significantly to improving problem-solving skills in various professions, including in the fields of mathematics, science, and psychology (Christi & Rajiman, 2023). In the context of mathematics education, computational thinking helps students in formulating problems, designing systematic solutions, and improving their cognitive abilities, especially when faced with non-routine problems or story problems Nurwita et al. (2022). Therefore, integrating computational thinking into the educational curriculum is a global necessity that cannot be negotiated.

Four key indicators computational thinkingaccording to the CSTA (Computer Science Teachers Association) as quoted by Asbell-Clarke et al. (2021) include problem decomposition (breaking the problem into small parts), pattern recognition (identifying similarities or regularity), abstraction (defining relevant information and ignoring irrelevant ones), and algorithmic thinking (systematically formulating solution steps). The main goal of computational thinking is to give students the confidence to make decisions in challenging situations, especially in mathematical problems, and to offer alternatives to solving complex problems through a variety of simple methods Kumar & Mohd (2024). These four indicators are very relevant to solving mathematical story problems in algebraic form material, because students are required to separate known and asked information, recognize the appropriate formula patterns, select the necessary data, and compile algebraic calculation steps gradually until finding the final solution Adu-Gyamfi et al. (2025).

However, the successful implementation of this ability does not depend only on the cognitive aspect. A student can understand the stages of decomposition, pattern recognition, abstraction, and algorithms procedurally, but internal psychological factors also determine how optimally the thinking process takes place Srinivasa et al. (2022). One of the most influential affective factors is self-esteem. Self-esteem is an individual's overall assessment of himself, both positive and negative, that includes feelings of worth, confidence, and acceptance of Rosenberg's strengths and weaknesses (1965). Molero et al. (2022) also stated that Self-esteem is one of the affective aspects that is very necessary because it is related to the ability, success, usefulness, and self-goodness of the individual. Research shows thatSelf-esteemA high level contributes positively to students' academic success because it encourages them to be more persistent, confident, and not give up easily in the face of challenges (Benites et al., 2025). Instead,Self-esteemlow ones often give rise to feelings of worthlessness, pessimism, and anxiety that can hinder logical and systematic thinking processes (Suhron, 2016).

A number of previous studies have explored the relationship between computational thinking and other affective or cognitive factors. Pramasdyahsari (2023) found that students with high mathematical problem-solving skills were able to meet all indicatorscomputational thinking, while low-ability students only meet some of the indicators. Research by Saig & Hershkovitz (2024) emphasizing the importance of implementing computational thinking in mathematics learning through the unplugged pedagogical tools, while Anistyasari et al. (2021)

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explore aspects of assessment (assessment ability computational thinking in the context of higher education. For example, the success of students in completing challenges computational thinking proven to increase their confidence and self-esteem according to López-Caudana (2024). Other research by (Maharani et al., 2024) shows that mathematical habits of mind (mathematical thinking habit) is high correlated with the achievement of all stages computational thinking, while low thinking habits only result in the fulfillment of some indicators. Nugraha & Hajaroh (2025) also reported that self-esteem make a positive, albeit small, contribution to students' critical thinking skills in the learning model blended learning. However, from these studies, there are still gaps (Gap) significant: there has not been much research that specifically and in-depth analyzes how students' computational thinking processes, step by step (decomposition, pattern recognition, abstraction, and algorithms), when viewed from the characteristics of self-esteemh igh and low directly. Most research still focuses on correlational relationships or indirect influences, not yet exploring qualitatively the subject's thinking experience in solving mathematical problems.

Noveltyof this study lies in the effort to fill the gap by using an in-depth exploratory qualitative approach. In contrast to previous studies that tended to be quantitative or only measured the level of achievement, this study will analyze in detail the subject's computational thinking process in each indicator. This research is supported by the socio-cognitive theory of (Bandura, 1986) which states that self-belief (self-belief) affects the way individuals think, motivate, and behave in the face of challenges. This theory is reinforced by the statement (Lee et al., 2024) that success computational thinking not only depends on cognitive ability, but is also influenced by students' self-confidence and self-regulation. Thus, this study offers a new perspective by combining cognitive analysis (computational thinking) and affective (Self-esteem) simultaneously in the context of solving algebraic problems at the junior high school level. Based on this background, this study is focused on comprehensively analyzing and describing students' computational thinking abilities in solving mathematical story problems in algebraic form materials, taking into account the level of self-esteem they have, both in the high and low categories. Specifically, this study aims to reveal how students with high self-esteem and how students with low self-esteem undergo each stage of computational thinking, starting from problem decomposition, pattern recognition, abstraction, to the preparation of solving algorithms.

Computational Thinking

Computational thinking (CT) in this study is interpreted as a thinking process used by students to understand, analyze, and solve a problem logically, systematically, and efficiently so that the solutions obtained can be applied to various contexts.(Proctor, 2023) which states that computational thinking It is a set of cognitive processes that involve problem formulation, data representation, and the preparation of solutions that can be implemented systematically. In the context of mathematics education, this ability plays an important role because it encourages students to think logically, make decisions based on available information, and develop problem-solving steps in a structured manner Mendrofa (2024). In line with the objectives of this study, computational thinking It is seen as a thinking ability that arises when students solve algebraic form story problems through systematic thinking stages.

In this study, computational thinking analyzed based on four indicators developed by Computer Science Teachers Association (CSTA), namely decomposition, pattern recognition, abstraction, and algorithmic thinking. Decomposition is the ability to decompose a problem into simpler parts so that it is easier to understand. Pattern recognition is the ability to find similarities, relationships, or regularity from available information. Abstraction is the ability to choose relevant information and ignore information that is not needed to get to the core of the problem. Meanwhile, algorithmic thinking is the ability to arrange solution steps in a sequential, logical, and efficient manner until a final solution is obtained Yasin & Nusantara (2023). The four indicators are interrelated and form a complete thinking process in solving mathematical problems.

The selection of CSTA indicators in this study is based on its suitability with the characteristics of algebraic form story problems used as research instruments. In the decomposition stage, students identify known information and questions in the problem. Furthermore, students identify patterns by determining the relationships between relevant algebraic information or concepts. The abstraction stage is carried out through the selection of information that is really needed to compile a mathematical model, while the algorithmic thinking stage is realized through the preparation of completion steps to obtain the right answer. Therefore, the four indicators are able to provide a comprehensive picture of the students' thinking process while solving mathematical problems, not just assessing the true or wrong final answer.

Relevance computational thinking With this research, the focus of research is not only to identify the achievement of indicators of computational thinking ability, but also to describe how the thinking process takes place when students have characteristics Self-esteem different Pasterk & Benke (2024). Various studies show that computational thinking influenced not only by cognitive abilities, but also by affective factors, such as confidence, motivation, self-regulation, and Self-esteem Lee et al. (2024). Students with Self-esteem tend to be more confident in determining a completion strategy, while students with Self-esteem low is more likely to indicate doubt, anxiety, or taking longer to make a decision (Azzahra, 2024). Therefore, this study looks at computational thinking as a thought process that is influenced by the interaction between cognitive and affective aspects so that analysis based on characteristics Self-esteem It becomes important to gain a deeper understanding of the mathematical problem-solving process.

Method

Type of Research

This research is qualitative research with the method used, namely exploratory research. According to Creswell Qualitative research is a way to explore and understand the meaning that individuals or groups give to a social or humanitarian problem. In this study, it aims to explore the ability to computational thinking students reviewed from Self-esteem. The selection of a qualitative approach is based on the characteristics of the research objectives which not only focus on the achievement of computational thinking indicators, but also on how the thinking process takes place when students solve mathematical problems. In this study, computational thinking skills are analyzed through four indicators, namely decomposition, pattern recognition, abstraction, and algorithmic thinking, taking into account the characteristics of students' self-esteem. Therefore, the data needed is not enough in the form of final results or problem solving scores, but also in the form of students' explanations of how to understand the problem, determine the information used, choose strategies, develop solution steps, and evaluate the answers.

The focus of the research is not to test the influence or relationship between self-esteem and computational thinking statistically, but to obtain an overview of the characteristics of the thinking process that emerge in each category of self-esteem. The exploratory approach allows researchers to trace the experiences, reasons, considerations, doubts, beliefs, and strategies used

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by students when solving problems, so that the differences in thinking processes between students with high and low self-esteem can be described in more depth. Written answers are used to identify the achievement of each indicator of computational thinking, while interviews are used to explore the reasons and thinking processes underlying the answers. Thus, an exploratory qualitative approach is considered appropriate to produce a complete description of the computational thinking process of students reviewed from the characteristics of high and low self-esteem.

Subject

The research subject is determined byPurposive(purposive sampling), by setting certain criteria that are in accordance with the focus of the research. The criteria for the subjects in this study are: (1) having participated in learning algebraic form material in class IX C SMP N 5 Tasikmalaya; (2) filling out the questionnaire Self-esteem completely; (3) Taking the test computational thinking individually; (4) represent the category Self-esteem high or low based on the results of the questionnaire; (5) have written answers that can be analyzed in depth; and (6) are willing to take part in interviews. Of the 29 students in class IX C, 8 students were obtained who met the four indicators, then 4 subjects were selected (2 with Self-esteem high and 2 with Self-esteem who are willing to be interviewed. According to Sugiyono (2022), the determination of purposive subjects is chosen according to certain considerations and objectives. It is important to note that the selection of subjects is not based on abilitycomputational thinkingthat have, but rather on the characteristics of Self-esteem. Capabilities computational thinking The subject is only known after an analysis of written answers and interviews.

Instruments

The instruments used in this study consisted of three types, namely self-esteem questionnaires, computational thinking ability tests, and semi-structured interview guidelines.

Table 1. Self-esteem questionnaire

Categories	Characteristics
Height	Feeling valuable, respecting himself but not admiring himself or expecting others to admire him in solving mathematical problems, not considering himself superior to others in solving mathematical problems, developing himself and improving himself in solving mathematical problems
Low	Determining to focus on protecting himself and not making mistakes in solving math problems, disappointed when experiencing failure and social anxiety in solving math problems, exaggerating negative events experienced in solving math problems, feeling awkward and embarrassed and unable to express himself when interacting with others, pessimistic and having inflexible minds in solving math problems

Ability test computational thinking The test is in the form of description questions that are arranged based on ability indicators computational thinking according to the CSTA (Computer Science Teachers Association) Asbell-Clarke et al. (2021). These indicators include problem decomposition, pattern recognition, abstraction, and algorithmic thinking. The questions given are contextual story questions about rectangular gardens with algebraic measurements.

Seorang tukang taman akan membuat 2 taman berbentuk persegi panjang. Panjang taman pertama (2x + 5) meter dan lebarnya (x +3) meter, panjang taman kedua (x + 4) meter dan lebarnya (x + 10) meter. Jika seluruh taman akan dipagari. Tentukan total keliling kedua taman dalam bentuk aljabar!

Figure 1. Computational Thinking Questions

The interview used is a semi-structured interview. According to Sugiyono (2022), semi-structured interviews are freer than structured interviews, the purpose of which is to find problems more openly, where the interviewee is asked for their opinions, experiences, and ideas. Interview guidelines are prepared to strengthen and reinforce the results of the written test, delve deeper into the subject's thought process, and reveal the affective aspects that accompany problem solving.

"What was the first thing you did when you read the question?"
"How do you determine the information that is known and questioned?"
"Do you see a particular pattern of the problem?"
"How do you know that formula or method can be used?"
"How do you determine the information that is known and questioned?"
"Did you ever feel confused when simplifying algebraic forms?"
"If your answer is wrong, what will you do?"
"Do you usually double-check your answers?"

Before being used in the research, the computational thinking ability test instrument had gone through a content validity test through expert judgment by two validators of Mathematics Education experts using an assessment scale of 1-5. Validation was carried out to assess the suitability of the instrument with computational thinking indicators, the suitability of algebraic form material, problem construction, and language clarity. Based on the results of the assessment of the two validators, the instrument was declared suitable for use after revision was made in accordance with the validator's suggestion. Because this study is a qualitative research with an exploratory method, the reliability of the instrument is not tested using statistical coefficients, but is maintained through triangulation techniques, namely comparing data obtained from self-esteem questionnaires, computational thinking ability tests, and interviews so that the credibility and consistency of the data can be guaranteed.

Data Collection

Data collection is a very important stage in this study because the main purpose of the research is to obtain valid and reliable information. As stated by Sugiyono (2022), a clear understanding of data collection techniques is necessary to ensure that the information collected is in accordance with the research objectives and meets the standards that have been set. In this study, data is collected through three stages. First, questionnairesSelf-esteemgiven to students to group them into categoriesSelf-esteemhigh and low based on the characteristics stated by the Rosenberg (1965). This questionnaire uses the Guttman scale with a choice of "Yes" or "No" answers, which consists of ten statements that reflect an evaluative attitude towards oneself, the questionnaire scoring is carried out by giving a score of 1 to answer "Yes" and 0 for the answer "No". Based on the results of the scoring, students with a score of 7-10 are categorized as having

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Self-esteem high, score 0-6 is categorized as having Self-esteem low. Second, students take a written test of abilitycomputational thinkingwhich consists of one story question in the form of a description in algebraic form material. This test is designed to reveal the problem-solving process of students based on four indicatorscomputational thinking, namely problem decomposition, pattern recognition, abstraction, and algorithmic thinking. The test was given individually to all 29 students of grade IX C at SMP Negeri 5 Tasikmalaya. Third, semi-structured interviews were conducted to gain a deeper understanding of the students' thinking process and to clarify the findings of the written answers. The interview guidelines include probing questions that explore how students interpret problems, identify important information, recognize patterns, select relevant data, formulate solution steps, perform calculations, re-examine answers, and show characteristics related to the levelSelf-esteem(high or low). Interviews were conducted with four selected subjects (two withSelf-esteemtall and two withSelf-esteemthat have met all four indicatorscomputational thinkingand be willing to be interviewed.

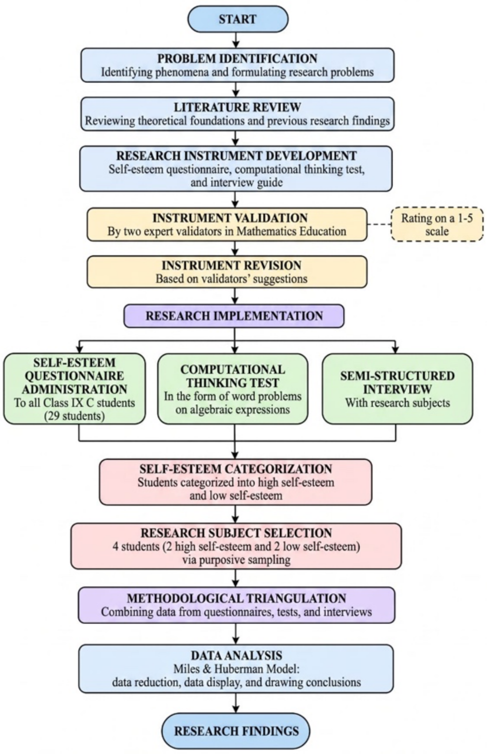

Figure 2. Research Flow

Data Analysis

The assessment of students' computational thinking abilities was carried out based on four indicators from CSTA Asbell-Clarke et al. (2021). The decomposition indicator is assessed from the ability of the learner to separate the information known and the asked in the question. The pattern recognition indicator is assessed from the learner's ability to recognize the rectangular circumference formula that is in accordance with the context of the question. The abstraction indicator is assessed from the learner's ability to choose relevant information and ignore information that is not needed. The algorithmic thinking indicator is assessed from the learner's ability to systematically compile completion steps until the final answer is obtained. Each indicator is assessed qualitatively with the category of "appearing" or "not appearing" based on the written answer and the interview results. The interview is conducted after the written test, which is 1-2 days after the implementation of the test, with a duration of 15-20 minutes for each subject. The entire interview process is recorded using a voice recorder on a smartphone, then transcribed verbatim (word for word) to facilitate analysis. This analysis process follows the steps described by Miles and Huberman, namely data reduction, data presentation, and drawing Sugiyono's conclusions (2022). The researcher grouped data from written answers and student interview results based on four ability indicatorscomputational thinking: problem decomposition, pattern recognition, abstraction, and algorithmic thinking. In each indicator, the researcher looked at characteristics that indicated Self-esteemhigh or low, such as confidence, persistence, anxiety, or doubt when formulating solution steps. The results of each student were then compared to find out the difference in problem-solving patterns between those who hadSelf-esteemhigh and low. To make the results clearer, the researcher used triangulation techniques. The researcher matched information from three sources: questionnaireSelf-esteemto find out the levelSelf-esteemstudents, a written test to see the abilitycomputational thinkingand interviews to dig deeper into their reasons and ways of thinking when working on the questions. By comparing the three, researchers can ensure that the conclusions drawn are really in accordance with the existing data.

Research Findings

The discussion in this study aims to provide an overview and results obtained to find out the analysis of computational thinking skills in solving mathematical problems, especially algebraic form materials in class IX C SMP Negeri 5 Tasikmalaya reviewed from self-esteem. Based on the results of the computational thinking ability test, 2 students who met the computational thinking indicators with high self-esteem and 2 students who met the computational thinking indicators with low self-esteem were obtained as shown in table 2 below.

Table 2. Subject

No	Subjects	Self-esteem
1	S-21	Height
2	S-20	Height
3	S-13	Low
4	S-6	Low

In Table 2 above, 4 subjects were selected, 2 students with high self-esteem, 2 students with low self-esteem. This is based on the results of the computational thinking ability test, filling out the self-esteem questionnaire, and interviewing. The following is a discussion of students' computational thinking skills , as for the questions used as follows.

Computational Thinking Ability with High Self-esteem

From the results that have been found by S-21 and S-20 with high self-esteem, when working on algebraic form computational thinking problems , it is known that S-21 and S-20 are able to solve all indicators. The following are the results of the computational thinking ability test in Figure 3 and Figure 4.

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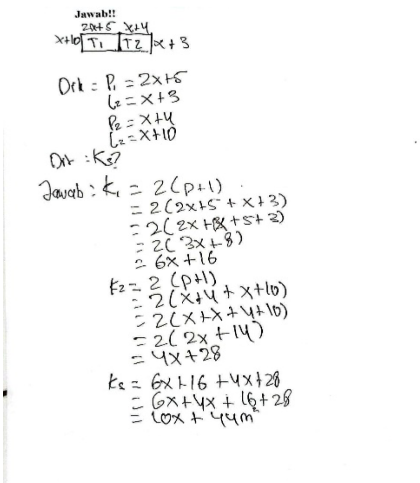

Figure 3. Answer S-21

Researcher : "What was the first thing you did when you read the question?"
S-21 : "Study the problem and understand it first"
Researcher : "How do you determine the information that is known and questioned?"
S-21 : "Read it carefully and then rewrite it."
Researcher : "Do you feel confident when determining the important parts of the problem?"
S-21 : "Confident"
Researcher : "Do you see a particular pattern of the problem?"
S-21 : "Yes, for example, it is rich in two gardens with different lengths and widths"
Researcher : "How do you know that formula or method can be used?"
S-21 : "Because what you are looking for is the circumference of the garden, so we use the formula of the circumference of the rectangle"
Researcher : "Did you ever feel confused when you simplified the form of algebra?"
S-21 : "No, it's not that easy"
Researcher : "If your answer is wrong, what will you do?"
S-21 : "Put in more effort, learn more"
Researcher : "Do you usually double-check your answers?"
S-21 : "Yes."

S-21 shows confidence in solving problems. Subjects are able to identify information completely, recognize rectangular circumference formula patterns, and do not experience confusion when simplifying algebra. S-21 always double-checks answers and commits to study harder if they are wrong.

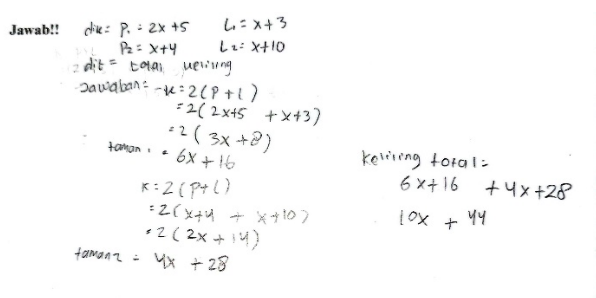

Figure 4. Answer S-20

Researcher : "How did you feel when you did the problem earlier?"
S-20 : "Quite calm and confident"
Researcher : "How do you determine the information that is known and questioned?"
S-20 : "Mark the important parts of the question, for example, numbers or algebraic forms, continue to separate which information is used and which should be searched"

Researcher	:	"Do you see a particular pattern of the problem?"
S-20	:	"Yes, I see a pattern similar to the exercises that have been given before, especially in the way of simplifying algebraic forms"
Researcher	:	"Did you ever feel confused when you simplified the form of algebra?"
S-20	:	"I was a little confused in the middle of the work, but I tried again the previous step and matched it with the algebraic formula until I found it."
Researcher	:	"If your answer is wrong, what will you do?"
S-20	:	"Double-check the steps again to find the wrong part, then fix it"
Researcher	:	"Do you usually double-check your answers?"
S-20	:	"Yes, I usually double-check the calculation to be surer of the correct answer"

The S-20 worked on the problem calmly and systematically, marking important information so as not to miss it. When confused, the subject repeated the previous steps until he found a solution. The S-20 was also used to verifying the final answer. Subjects in the high category were able to meet all indicators. This is evidenced by the results of the researcher's data analysis which explained that subjects with high self-esteem were able to meet all computational thinking indicators. There is a difference in the completion process, where S-21 more directly understands the problem by studying the information known and asked and feels confident in the chosen step. He has found problems that are poor in learning algebra and does not experience difficulties when simplifying algebraic forms. Meanwhile, S-20 can meet all the indicators of computational thinking, but more often checks important information so as not to miss and had a little confusion when simplifying the algebraic form, so he tried to repeat the previous steps to make sure the answer was appropriate.

Computational Thinking Ability with low Self-esteem

From the results of the analysis that has been carried out by researchers on S-13 and S-6 with low self-esteem, when working on algebraic form computational thinking problems , it is known that S-13 and S-6 are also able to solve all computational thinking indicators. The following results of the computational thinking ability test is shown in Figure 5 and Figure 6.

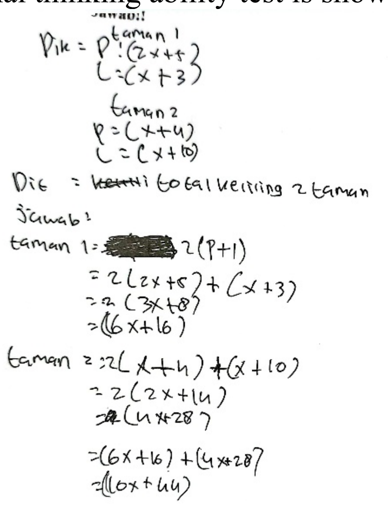

Figure 5. Answer S-13

Researcher	:	"How did you feel when you did the problem earlier?"
S-13	:	"I was a bit nervous and afraid of making a mistake when I did it, I was confused about where to start"
Researcher	:	"What was the first thing you did when you read the question?"
S-13	:	"Reading questions several times for fear of misunderstanding"

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Researcher	:	"Do you feel confident when determining the important parts of the question?"
S-13	:	"Not very sure"
Researcher	:	"How do you know that formula or method can be used?"
S-13	:	"Just trying what formula, I remember"
Researcher	:	"Did you ever feel confused when simplifying algebraic forms? How do you solve it?"
S-13	:	"Yes, it's quite confusing. Usually look at the previous example or pause for fear of making mistakes"
Researcher	:	"If your answer is wrong, what will you do?"
S-13	:	"Confused about which one to fix and more disappointed"
Researcher	:	"Do you usually double-check your answers?"
S-13	:	"Rarely, because sometimes I am even more unsure after being rechecked"

S-13 admitted to being nervous and unsure when determining important information. Subjects only tried memorized formulas without confidence and tended to stop when confused for fear of getting more wrong. S-13 rarely checked the answers because they were worried that they were getting more unsure.

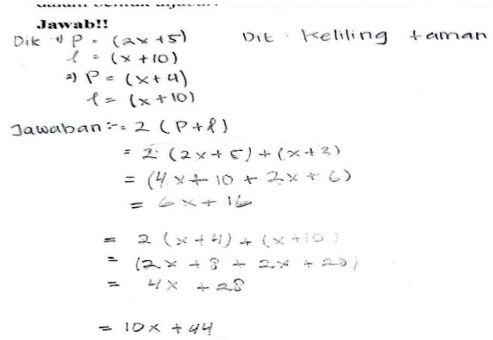

Figure 6. Answer S-6

Researcher	:	"How did you feel when you did the problem earlier?"
S-6	:	"A little panicked, because the formula was a little forgetful"
Researcher	:	"What was the first thing you did when you read the question?"
S-6	:	"It's hard to understand, because I don't know the formula, the first time I work on it, ask my friend first, after knowing the formula, I immediately work on it"
Researcher	:	"Do you feel confident when determining the important parts of the problem?"
S-6	:	"I'm not too sure, still hesitant because I don't know at first"
Researcher	:	"How do you know that formula works?"
S-6	:	"Because from the algebra is rich and from what is asked"
Researcher	:	"Did you ever feel confused when you simplified the form of algebra?"
S-6	:	"No"
Researcher	:	"If your answer is wrong, what will you do?"
S-6	:	"Work on it again, find the answer to be correct"
Researcher	:	"Do you think you should check your answer again?"
S-6	:	"Yes, check again"

S-6 panicked and asked his friend because he forgot the formula. After knowing the correct formula, the subject was able to solve the problem. S-6 showed a willingness to rework if the answer was wrong and double-checked. Subjects in the low category were able to meet all indicators of computational thinking. This is evidenced by the results of the researcher's data analysis which explained that subjects with low self-esteem categories were able to meet all indicators of computational thinking. But the completion process was slightly different. Where S-13 admitted that he felt nervous, afraid of making mistakes, and read the problem several times because he was worried that he misunderstood the problem. When determining patterns and simplifying algebraic forms, S-13 still showed doubts and relied on the formula remembered from previous experiences. Meanwhile, S-6 felt panicked at the beginning of the work because he forgot the formula and even told his friend, but after knowing the formula used, the subject could continue to solve the problem.

Discussion

The findings of this study show that students with high (S-21, S-20) and low (S-13, S-6) self-esteem are both able to meet all four indicators of computational thinking (CT) ability cognitively, but the fundamental difference lies in the affective qualities that accompany their thinking process. Subjects with high self-esteem show a systematic, structured, efficient flow of thinking, and supported by confidence, calmness, and persistence. On the other hand, subjects with low self-esteem even though they were procedurally able to solve problems, their processes were colored by doubt, anxiety, lack of confidence, and maladaptive behaviors such as panicking and asking friends in the early stages of work. This shows that self-esteem does not always determine the achievement of computational thinking indicators but plays a role in the quality of thinking experiences when students solve mathematical problems. These findings are in accordance with the results of this study which show differences in thinking processes even though computational thinking indicators can be achieved by all subjects.

The findings support social-cognitive theories (Bandura, 1986) that self-confidence influences the way individuals think and act when faced with challenges. Students with Self-esteem seem to have confidence in their abilities so that they are more courageous to make decisions, evaluate their work, and persist when encountering difficulties. On the other hand, students with Self-esteem tend to be more likely to doubt the decisions that have been made, so that the thought process becomes less efficient. In addition, these characteristics are also in accordance with Rosenberg's theory which states that individuals with Self-esteem have a positive appreciation of themselves, while individuals with high Self-esteem Low are more prone to experiencing anxiety and doubts about their abilities.

The results of this study are in line with the research Haniifah & Nugraheni, (2024) which states that the success of computational thinking is not only influenced by cognitive ability, but also by affective factors such as self-confidence and self-regulation. The findings of this study reinforce this opinion because all subjects have relatively similar cognitive abilities in meeting the indicators computational thinking, but the quality of their thought process differs according to the characteristics Self-esteem each. Thus, the affective aspect plays a role as a factor that affects how students carry out each stage of computational thinking.

At the same time, expanding the results of Rahmatika Diah Silvia's research, Agnita Siska Pramasdyahsari (2023) and (Maharani et al., 2024) by showing thatSelf-esteemlow does not hinder the fulfillment of CT cognitive indicators, but rather creates an affective burden in the form of anxiety and doubt that has not been revealed in previous quantitative research. Similarly, López-Caudana (2024) explains that success in completing a task is based on computational thinking can increase students' confidence. In this study, it was seen that students with Self-esteem showed greater confidence when determining a solution strategy, while students with Self-esteem low experience more anxiety before getting an answer that is considered correct.

In contrast to previous research which mostly used a quantitative approach to measure the relationship between self-esteem and thinking ability, this study provides a qualitative overview of how the computational thinking process takes place in each indicator. Analysis through written tests and interviews shows that differences in self-esteem are more visible in

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the way students understand problems, make decisions, maintain solution strategies, and evaluate answers rather than simply differences in computational thinking ability scores. Therefore, this study provides a new contribution in the form of an in-depth description of the dynamics of students' thinking processes based on self-esteem characteristics.

The results of this study show that the success of learning computational thinking It is not enough to focus only on mastering mathematical concepts, but also to pay attention to the affective conditions of students. Teachers need to create a safe learning environment, provide constructive feedback, and encourage students to dare to try various solution strategies without fear of making mistakes (Tang et al., 2025). Such a learning environment is believed to be able to improve Self-esteem At the same time, optimizing the quality of students' computational thinking process. Thus, this study confirms that self-esteem is not a factor that determines whether students are able to meet the indicators of computational thinking or not, but rather affects the quality of the thinking process during the resolution of mathematical problems. Students with high self-esteem show a more systematic, confident, and reflective thinking process, while students with low self-esteem tend to need greater emotional support to be able to show their best thinking skills. These findings expand the study of the relationship between cognitive and affective aspects in mathematics learning.

The implications of the findings on learning, the results of this study show that the development of computational thinking skills does not only depend on mastery of mathematical concepts, but is also influenced by the affective conditions of students, especially self-esteem. Therefore, teachers need to consider the characteristics of students' self-esteem when designing learning so that every student has the same opportunity to develop computational thinking skills. For students with high self-esteem, teachers can provide more open-ended problems, investigative projects, and assignments that require the exploration of various solution strategies so that their computational thinking skills are further developed. Meanwhile, for students with low self-esteem, teachers need to provide gradual scaffolding, positive feedback, reinforcement of every small success, and create a classroom atmosphere that does not emphasize mistakes as a form of failure, but as part of the learning process. In addition, learning based on group discussions, problem-based learning, and inquiry learning can be used to increase students' confidence through positive social interaction. Thus, computational thinking learning not only develops students' cognitive abilities, but also supports the development of affective aspects that are the basis for the emergence of confidence in solving mathematical problems.

Conclusion

Based on the results of the study, it was concluded that students with high self-esteem were able to meet all indicators of computational thinking systematically, confidently, and diligently, while students with low self-esteem were also able to meet the indicators procedurally but their thinking process was colored by doubt, anxiety, and lack of confidence. This study has weaknesses including limitations in algebraic form materials, small number of subjects, Guttman-scale self-esteem instrument that is less sensitive to capturing the dynamics of self-esteem, and short research time so that the results cannot be generalized widely. Therefore, it is recommended for future researchers to expand the scope of material and the number of subjects, use more sensitive self-esteem instruments (e.g. Likert scale), examine other affective variables such as mathematical anxiety or self-efficacy, use mixed-method or experimental designs to test the effectiveness of self-esteem enhancement interventions, and conduct longitudinal studies to see the development of CT capabilities in the long term.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Auhor Contributions

A.M. conceptualized the research idea presented, collected and organized the data, and prepared the initial draft of the manuscript. I.M. actively contributed to the development of the methodology, data analysis, and discussion of the findings. R.R. contributed to the development of the theoretical framework, revision of the manuscript, validation of the results, and approval of the final version of the work. All authors confirm that they have read and approved the final version of this manuscript. The percentage contributions for the conceptualization, drafting, analysis, and revision of this paper are as follows: A.M.: 60%, I.M.: 20%, R.R.: 20%.

Data Availability Statement

The authors state that the data supporting the findings of this study will be made available by the corresponding author, I.M., upon reasonable request.

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