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Analysis of students' computational thinking skills in solving algebraic problems in cultural contexts

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Abstract: This research aims to find out about students' computational thinking abilities in solving algebraic problems in cultural contests. This research is qualitative research carried out at Yogyakarta Middle School. The participants involved were 31 students in the even semester of grade 7. The data sources in this research were the results of students' computational thinking tests, interviews with students who were selected based on their communication skills and the results of test answers. Data instrument testing uses validity and reliability tests with data validity using triangulation techniques. Data analysis in this study used the pullulation technique between student test results and student interview results, then data reduction, data categorization, power display and conclusion drawing were carried out. The results of this research are that students in the high category can complete all indicators of computational thinking and problem-solving abilities. Students in the medium category can only complete two indicators of computational thinking and problem-solving abilities. Students in the low category have not been able to complete all indicators of computational thinking and problem-solving abilities. The study reveals a significant variance in the computational thinking abilities among junior high school students in Piyungan Development class VIII when solving algebra problems within a cultural context. High-achieving students demonstrated proficiency across all indicators of computational thinking, effectively navigating through various stages from abstraction to solution verification. In contrast, students categorized as moderate showed partial success, managing only a subset of the indicators, while struggling with the more complex stages of problem decomposition and implementation. Meanwhile, students classified in the low category were unable to achieve any indicators of computational thinking and problem-solving skills. This indicates a clear need for targeted educational interventions to enhance computational thinking among students, particularly those who are struggling, to ensure all students can develop the necessary skills to solve problems effectively.

Keywords: *Computational thinking, Cultural context, Problem solving.*

1. Introduction

In the era of globalization, the rapid development of technology, seen through artificial intelligence and all materials related to the internet is a link between humans and machines [1]. The integration of

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computing into every factor of activity has brought great utility to individuals. For the same time, this problem also poses new challenges for future generations to be competent in global competition. What can be done to overcome future challenges is to build a plan to advance the capabilities needed.

Computational thinking is the main ability in the current era [2]. Computational thinking doesn't just think like a computer algorithm but students are required to have the ability to think critically, creatively, communication, and collaborative problem-solving skills [3, 4]. Computational thinking also combines knowledge of logic, mathematics, and mechanics through knowledge of modern technology, digitalization, and computerization, even forming a confident, open, tolerant, and environmentally sensitive personality [5]. When students can apply computational thinking skills, mathematics is no longer considered difficult and problem-solving skills in students increase. Computational thinking is closely related to calculation, mathematics, algorithms and rationality [6]. Therefore, computational thinking is able to support to support quality and advance teaching and learning outcomes in schools.

Some previous research reveals about computational thinking. Computational thinking students with higher mathematical logic intelligence when completing work such as decomposition, pattern recognition, algorithmic thinking, as well as generalization and abstraction [7, 8]. The students with high category abilities can solve all computational thinking indicators, students with sufficient categories can solve abstract computational thinking indicator problems, look for equations or patterns and describe problems, while students with low category abilities can solve computational thinking indicator problems abstract and look for equations or patterns while outlining problems and thinking algorithms are bad [9]. Students with high computational thinking ability complete indicators clearly, precisely and relevantly [10]. Students with computational thinking skills are completing indicators appropriately and relevantly according to aspects of concepts and ideas. This study aims to find out about students' computational thinking skills on solving algebra problems in cultural contests. This research is expected when the results have been obtained it can be used as a guideline for teachers in planning a lesson and students can improve computational thinking skills in solving mathematical problems.

Problem-solving ability is the main target of mathematics learning, so it is very useful for teachers to understand students' abilities when solving mathematical problems [11]. Students face problems in solving mathematical problems due to lack of knowledge when exploring mathematical problems in the form of stories, lack of theoretical deepening, lack of accuracy in the process of solving computational problems and lack of ability to relate context to one another. Therefore, problems in learning mathematics affect the ability to solve mathematical problems [12].

In interactive mathematics learning, mathematical communication skills are needed to grow students' skills in the surrounding cultural aspects. Learning not only provides learning content, but also conveys other useful content such as introducing local cultural backgrounds, which can foster in students character values that do not deviate from character goals culture [13]. Considering that local culture has been integrated with foreign culture, the current generation may not understand or understand the local culture of their own region. Integrating cultural factors in learning should start from the culture of the closest environment [14, 15]. Through the introduction of local culture, local culture is certainly more advanced. Various mathematical concepts can be explored and obtained in culture, thus making it clear that mathematics with culture is equally related, mathematics can be formed through culture, mathematics can be explored in culture, so that it can be used as a reference for learning specific and student-centered mathematics [16-18]. This culture can be integrated in learning mathematics with algebra material.

Computational thinking in mathematics learning will help students know that mathematics is not just about getting the right results for a problem, but also about understanding the problem and there is no single solution. In this sense, the problem-solving approach is designed to enable students to understand mathematics and the importance of mathematics in this life. Problem solving not only involves the application of conceptual mathematics but to understand the true value of mathematics in everyday life [19]. Therefore, computational thinking exists to approach problem solving. The main

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goal is to develop numeracy skills and help students of all ages motivate different skills needed to develop problem-solving skills. Based on the ability of computational thinking to develop through cultures in the surrounding environment, because the culture around us is very much to be able to expand students' knowledge. Therefore, computational thinking can be related to learning mathematics with a cultural context, to foster a student's problem-solving skills.

Based on the description above, it is important to conduct research related to analysis of Students' Computational Thinking Abilities on Solving Algebraic Problems in Cultural Contexts. The purpose of this study was to find out about students' computational thinking skills on solving algebra problems in cultural contests. This research is expected when the results have been obtained it can be used as a guideline for teachers in planning a lesson and students can improve computational thinking skills in solving mathematical problems.

2. Research Methods

2.1. Research Model

This study was conducted using a descriptive method. Descriptive research explains and responds to a line of activities related to the analysis of events, events, or social situations. The research was conducted at Middle School in Yogyakarta.

2.2. Participants and Data Collection

The subjects of this study were eighth grade students totaling 31 students at Middle School in Yogyakarta for the 2023/2024 academic year. The subject selection technique in this study uses the technique of selecting the subject of data sources through certain considerations. The object of this study is the analysis of students' computational thinking skills in solving algebra problems in a cultural context with the subject matter of the Two Variable Linear Equation System.

2.3. Research Tools

The source of this research data is the primary data source with data instrument trials using validity tests and reliability tests with data validity using triangulation techniques carried out by analogizing and reviewing written data student responses and student interview results. Data Analysis in this study uses data collection techniques through the interview and test stages, data education, categorization through 3 categories (high, medium, low category students), data displey, and conclusions. Then the collected data is analyzed using qualitative data and presented descriptively describing the results of each stage of development. The data were analyzed using computational thinking ability indicators and problem-solving ability indicators that were used as guidelines for solving a mathematical problem, namely Table 1.

Table 1.
Indicator of computational thinking and problem solving.

No	Indicator	
	Computataional thinking	Problem solving
1.	Abstraction	understanding problem
2.	Pattern recognition	devising a plan
3.	Decompotition	carrying out the plan
4.	Algorithms	looking back

2.4. Study Results

Based on the results of the students' *computational thinking* ability test on solving algebraic problems in the cultural context that have been carried out by students, the results of the student *computational thinking* ability test on the Two Variable Equation System material are students who have a high category in *computational thinking* skills. In problem solving as many as 2 students, then students who

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have a medium category in *computational thinking* ability in problem solving as many as 4 students and students who have a low category in *computational thinking ability* in problem solving as many as 24 students, are presented in the Table 2 as follows:

Table 2.
Category of students.

Category	Number of students
High	2
Medium	5
Low	24
Total	31

Based on Table 2, researchers chose three students as research subjects, i.e., a student with a high category on *computational thinking* skills in problem solving, a student with medium categories on *computational thinking* skills in problem solving and a student with low categories on *computational thinking* skills in troubleshooting. The selection of subjects refers to students who have problem-solving abilities based on predetermined indicators.

Subjects with high categories are ST-1, then for subjects with medium categories are SS-1 and for subjects with low categories are SR-1. The next step is to conduct interviews with the three subjects that have been selected. The interview was conducted to deepen information about a subject's obstacles when working on the questions that had been given.

2.4.1. Computational Thinking Ability in Problem Solving Students with High Categories

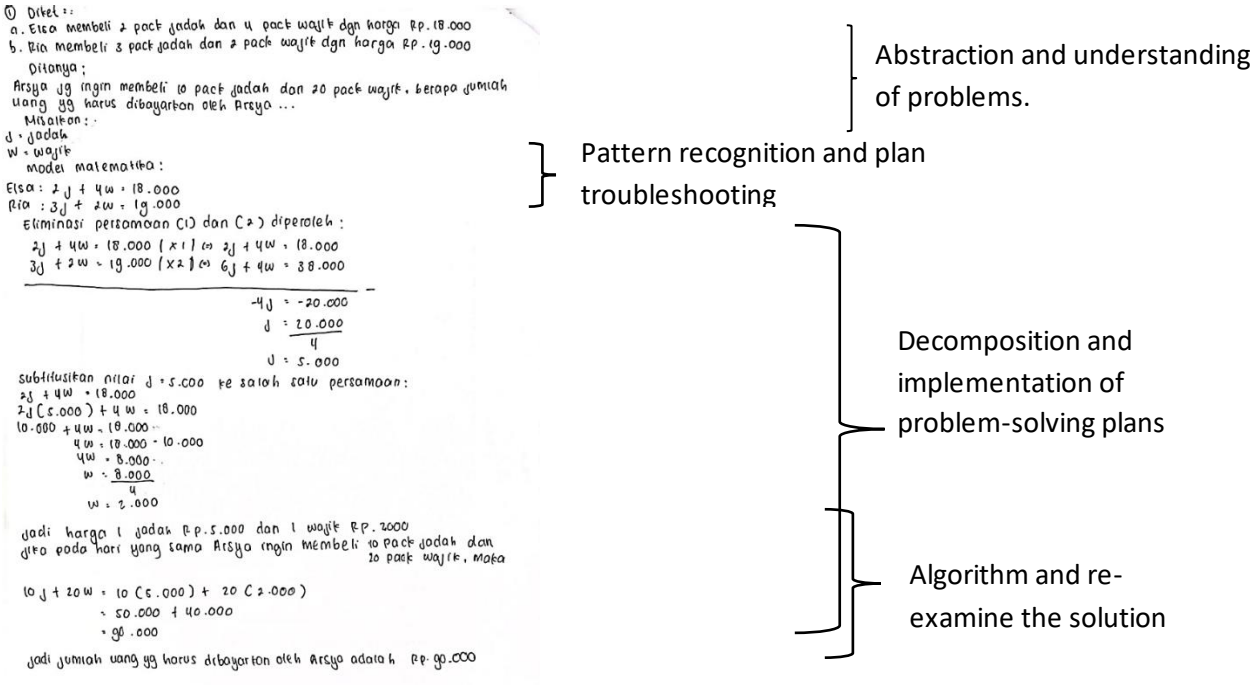

Figure 1.
ST-1 Student test results number 1.

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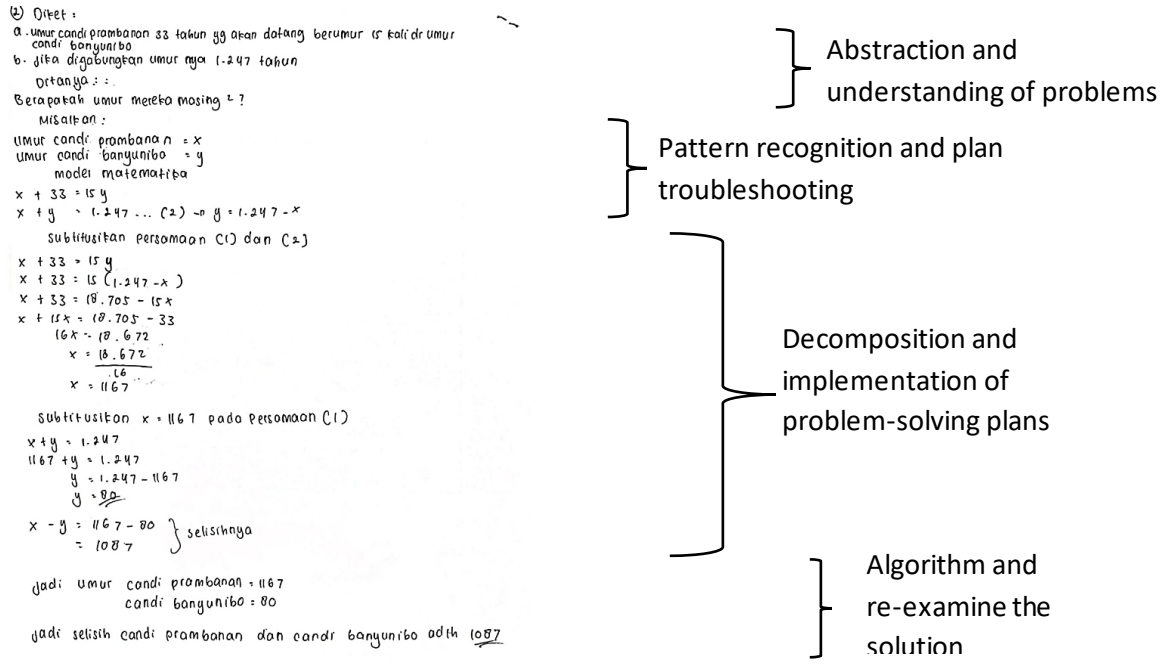

Figure 2.
ST-1 student test results number 2.

2.5. Abstraction Ability and Problem Understanding Ability

Based on the results of tests and interviews, students with high categories in solving questions number 1 and 2 students can mark the main information on the problems that have been given, by writing down what is known and asked on the questions, so that students with high categories are considered capable *in abstraction* and understand the problem.

2.6. Pattern Recognition and Problem-Solving Planning Capabilities

Based on the results of tests and interviews, students with high categories in solving questions number 1 and 2 students can make patterns, characteristics or objects that are similar in solving problems, by writing down examples of what is already known, asked and modeling into mathematical form, so that students with high categories are considered capable of *pattern recognition* and planning problem solving.

2.7. Decompotition Ability and Ability to Implement Problem Solving Plans

Based on the results of tests and interviews, students with high categories in solving questions number 1 and 2 students can recognize problems into simple forms by compiling existing patterns, completing the patterns obtained and implementing problem solving plans systematically with precise calculations, so that students with high categories are considered capable of *decompotition* and implementing problem solving plans.

2.8. Algorithms and Ability to Re-examine Solutions Obtained

Based on the results of tests and interviews, students with high categories in solving questions number 1 and 2 students can explain again ways of solving problems, conclude the results of the work obtained and always check the answers that have been obtained, so that students with high categories are considered capable in algorithms and re-examine the solutions obtained

In the above it can be concluded that students with high categories are able to complete all indicators *computational thinking* and in-stage problem-solving capabilities abstraction and the stage of

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understanding the problem well [20]. Students with high categories are able in the stage pattern recognition and the stage of planning problem solving well. Students with high categories are able in the stage decomposition and the stage of executing the problem solving plan well [21]. Students with high categories are able to in the stage algorithm and re-examine the well-obtained solution [7].

2.8.1. Computational Thinking Ability in Problem Solving Students with Moderate Category

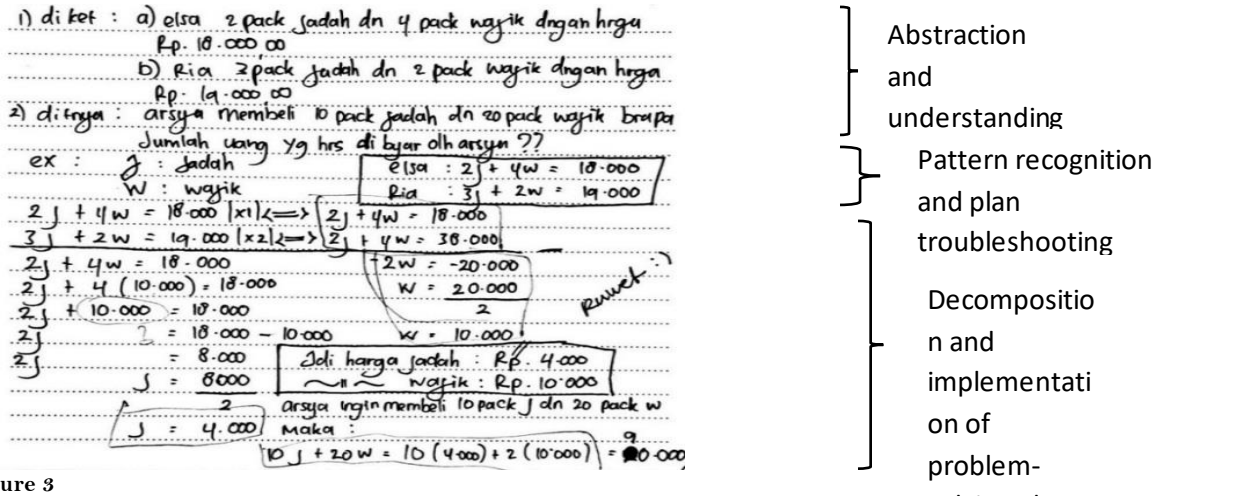

Figure 3
SS-1 student test results number 1.

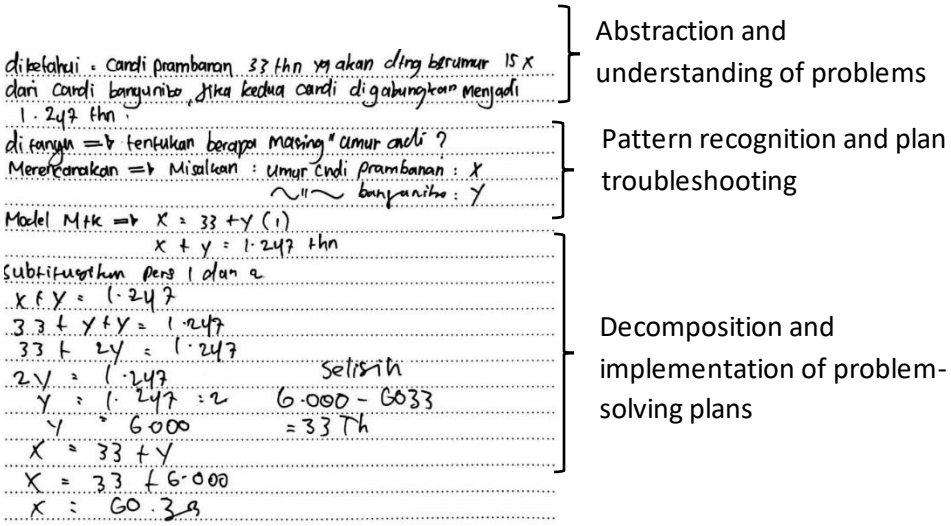

Figure 4.
SS-1 student test results number 2.

2.9. Abstraction Ability and Problem Understanding Ability

Based on the results of tests and interviews, students with medium categories in solving questions number 1 and 2 students can mark the main information on the problems that have been given, by writing down what is known and asked on the questions, so that students with medium categories are considered capable *in* abstraction and understand the problem.

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2.10. Pattern Recognition and Problem-Solving Planning Capabilities

Based on the results of tests and interviews, students with categories are in solving problem number 1 students when making patterns, characteristics or objects that are similar in solving problems, some write and do not write examples of what is already known, asked and modeled into mathematical form. For problem number 2 students with medium categories in making patterns, characteristics or objects that are similar in solving problems only write down examples of what is known, but when modeling into mathematical form, so that from questions number 1 and 2 students with medium categories are considered capable in pattern recognition and plan problem solving.

2.11. Decompotition Ability and Ability to Implement Problem Solving Plans

Based on the results of tests and interviews, it can be seen that students with medium categories in solving questions number 1 and 2 students can recognize problems into a simple form by compiling existing patterns, completing the patterns obtained and implementing problem solving plans systematically, but in doing calculations not properly starting from the beginning, so that students with medium categories are considered unable to decomposition and carry out a problem-solving plan.

2.12. Algorithms and Ability to Re-examine Solutions Obtained

Based on the results of tests and interviews, students with the category of being in solving question number 1 can explain again ways of solving problems and some cannot explain back ways of solving problems, conclude the results of the work obtained, but the results are not correct and recheck the answers that have been obtained. For question number 2 students with the medium category cannot explain the ways of solving problems, do not conclude the results of the work obtained and do not recheck the answers that have been obtained, so students with the medium category are considered unable to in algorithms and re-examine the solutions obtained.

In the above it can be concluded that students with medium categories can only complete two indicators *computational thinking* and problem-solving ability i.e. stage abstraction and the stage of understanding the problem as well as stages pattern recognition and the stage of planning good problem solving [3, 8]. Students with moderate categories are not yet capable in the stage decomposition and the stage of implementing the problem solving plan. Students with moderate categories are not yet able to in the stage algorithm and re-examine the solution obtained.

2.12.1. Computational Thinking Ability in Problem Solving Students with Low Categories

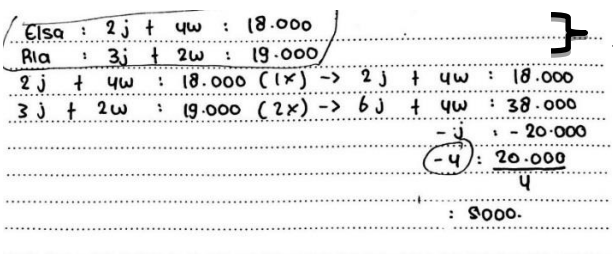

Figure 5.
SR-1 student test results number 1.

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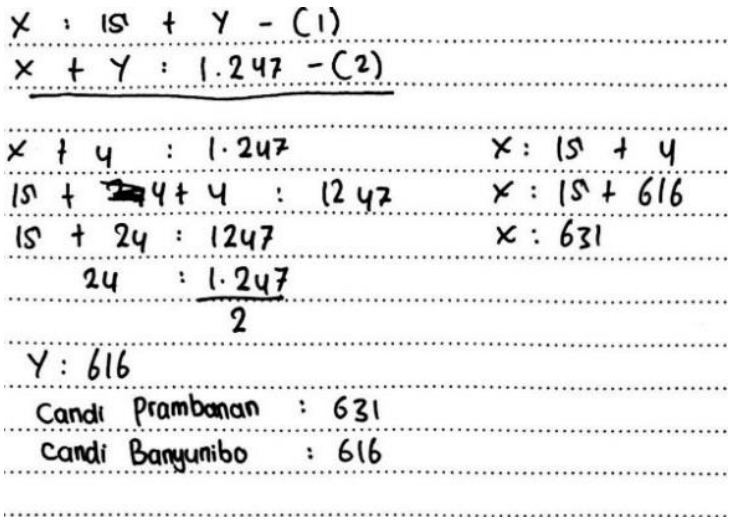

Figure 6.
SR-1 student test results number 2.

2.13. Abstraction Ability and Problem Understanding Ability

Based on the results of tests and interviews, students with low categories in solving questions number 1 and 2 students cannot mark the main information on the problems that have been given, because students with low categories do not write down what is known and asked on the questions, so students with low categories are considered unable to abstraction and understand the problem.

2.14. Pattern Recognition and Problem-Solving Planning Capabilities

Based on the results of tests and interviews, it can be seen that students with low categories in solving problem number 1 students when making patterns, characteristics or objects that are similar in solving problems, do not write down examples of what is already known, but write down what is asked by modeling into mathematical form, For question number 2 students with low categories in making patterns, Similar characteristics or objects in solving problems do not write down examples of what is already known, asked and modeled into mathematical form so that from questions number 1 and 2 students with low categories are considered unable to pattern recognition and plan problem solving.

2.15. Decompotition Ability and Ability to Implement Problem Solving Plans

Based on the results of tests and interviews, students with low categories in solving questions number 1 and 2 students cannot recognize problems into simple forms by arranging existing patterns, completing the patterns obtained and implementing problem solving plans systematically, so that students with low categories are considered unable to decomposition and implement problem solving plans.

2.16. Algorithms and Ability to Re-examine Solutions Obtained

Based on the results of tests and interviews, students with low categories in solving questions number 1 and 2 cannot explain back ways of solving problems, do not conclude the results of the work obtained and do not recheck the answers that have been obtained, so students with low categories are considered unable to algorithms and re-examine the solutions obtained.

In the above it can be concluded that students with low categories have not been able to complete all indicators *computational thinking* and in-stage problem-solving capabilities abstraction and the stage of understanding the problem. Students with low categories have not been able to in the stage pattern recognition and the stage of planning troubleshooting [20, 22, 23]. Students with low categories have

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not been able to in the stage decomposition and the stage of implementing the problem-solving plan. Students with low categories are not yet capable in the stage algorithm and re-examine the solution obtained [21].

3. Conclusion

Based on the results of the study, it can be concluded that the ability computational thinking students in solving algebra problems in a cultural context in junior high school students of Piyungan Development class VIII, namely students with high categories able to complete all indicators computational thinking and problem-solving skills that are in the stage abstraction and the stage of understanding the problem, then the stage pattern recognition and the stage of planning the next problem solving stage decomposition and stages of implementing the problem solving plan as well as stages algorithm and re-examine the well-obtained solution. Students with a moderate category can only complete 2 indicators computational thinking and problem-solving ability i.e. stage abstraction and the stage of understanding the problem as well as the stage pattern recognition and the stage of planning problem solving well. While in the stage decomposition and stages of implementing the problem-solving plan as well as stages algorithm and re-examine the solutions obtained by students with moderate categories have not been able to solve them. Students with low categories have not been able to complete all indicators computational thinking and problem-solving ability i.e. in the abstraction and the stage of understanding the problem, the stage pattern recognition and the stage of planning problem solving, the stage decomposition and the stage of implementing the problem-solving plan, as well as the stage algorithm and re-examine the solution obtained.

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