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STUDENTS' THINKING PROCESS IN SOLVING MATHEMATICAL LITERACY PROBLEM BASED ON COGNITIVE STYLE

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ABSTRACT. Literacy is becoming the world's great hope. Various countries are looking for ways to improve literacy skills, including mathematical literacy. Literacy is the key to empowering students. There are three components of mathematical literacy, namely context, content, and process. This study aims to describe students' thinking process in solving mathematical literacy problems in terms of reflective and impulsive cognitive styles. The student's mathematical thinking process refers to three phases: entry, attack, and review. This type of research is descriptive qualitative with research subjects selected using the Matching Familiar Figure (MFF) cognitive style test on 7 grade IX students from four different junior high schools. The MFF test results obtained that two students had a reflective cognitive style, two students had an impulsive cognitive style, one student was slow inaccurate, and two students were fast - accurate. Then a mathematical literacy test is given to students who have reflective and impulsive cognitive styles. This study concluded that there were differences in students' thought processes in solving mathematical literacy problems between students who had reflective and impulsive cognitive styles. Students with a reflective cognitive style do not go through one phase looking for other problem-solving strategies. The student's thinking process with impulsive cognitive style did not reach the review phase, especially in the reflect and extend phase. Students cannot reflect on ideas and ideas in solving problems, do not make generalizations, and have difficulty finding alternative solutions to problem-solving.

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1. INTRODUCTION

Literacy is hot topic of conversation among the international community and is the world's great hope. Various countries are actively conducting literacy assessments and looking for ways to improve literacy skills. They have realized that to face an increasingly complicated world requires a young generation who is responsive and critical. Mujulifah, Sugiatno and Hamdani (2015) argue that the higher the literacy understanding of a nation, the more policies issued are faster, more precise, and rational to bring prosperity to a nation as a whole. UNESCO (2016) also argues that literacy has a multiplier effect, eradicating poverty, reducing child mortality, curbing population growth, achieving gender equality, and ensuring sustainable development, peace, and democracy.

Mathematical literacy is a skill that needs to be developed because many activities in life are related to mathematics and require literacy skills to solve them. Kusumah (2012) argues, in life in this modern age, everyone needs to have mathematical literacy to use when facing various problems because mathematical literacy is very important for everyone related to work and life tasks. OECD (2013) stated that mathematical literacy could help a person understand the role or use of mathematics in life.

Indonesia is one of the countries that pay serious attention to literacy. Indonesia's position in the world has become one of the triggers. Based on PISA for 2000, 2003, 2006, 2009, 2012, 2015, and 2018, Indonesian students' mathematical literacy is still low. Some of the reasons are that the character of questions in school is not developed such as PISA questions (Stacey, 2011), PISA questions use a context that is unfamiliar to students (Mahdiyansyah and Rahmawati, 2014) so that students are less trained in working on contextual problems and demand high-order thinking (Budiman and Jailani, 2014). PISA's focus is literacy, which emphasizes students' skills and competencies to be used in life and various situations (Johar, 2012).

One effort that can be made to develop mathematical literacy is to look at students' thinking processes in solving math problems. Good thinking skills will help students understand mathematical concepts more quickly. Therefore, teachers need to have a good picture of students' thought processes in solving math problems because students have thought processes that are not always the same (Yanti and Syazali, 2016). Besides, student characteristics (cognitive style) need to be considered in learning activities (Daraini, 2012).

Mathematical thinking is a dynamic process that allows someone to broaden their understanding and increase the complexity of ideas in solving problems through the entry, attack, and review phases (Mason, 2010). The entry phase is to find the meaning and purpose of the problem. The attack phase is to find solutions to problems in logical ways and be understood by others. The review phase to solve problems involves using ideas gleaned from experience. According to Liu and Ginther (1999), cognitive style

refers to individual characteristics and consistency in feeling, remembering, organizing, processing, thinking, and solving problems. Kagan (1965) divides cognitive styles into two, namely reflective cognitive styles and impulsive cognitive styles. The reflective cognitive style has the characteristics of being slow in answering problems but careful or thorough so that the answers tend to be correct. Meanwhile, the impulsive cognitive style has the features of being fast in answering problems but not / less accurate so that the answers tend to be wrong. Reflective and impulsive cognitive styles are divided into four groups, namely reflective, impulsive, fast-accurate, and slow-inaccurate (Rozencwajg and Corroyer, 2005).

This research was conducted to obtain an overview of students' mathematical thinking processes in solving mathematical literacy problems in terms of reflective and impulsive cognitive styles. Tracing students' mathematical thinking processes was carried out by describing a cognitive map containing three phases: (1). Entry consists of know, want, and introduce; (2). Attack consists of try, maybe, and why; (3). Review consists of check, reflect, and extend.

2. Materials and Methods

This type of research is qualitative descriptive research. The research subjects were selected using a cognitive style test in the form of Matching Familiar Figure (MFF), which was developed by Warli (2010) by adopting Jerome Kagan in 1965. There are 13 pictorial questions and two experimental questions to understand the tasks that must be done. The following are the results of measuring the cognitive style of the seven students:

Table 1. Cognitive Style Measurement Results

No	Subject	t	f	Cognitive Style
1	S1	23,58	1,98	Slow - Inaccurate
2	S2	37,21	1,67	Reflexive
3	S3	20,57	1,56	Reflexive
4	S4	12,60	3,43	Impulsive
5	S5	13,75	3,25	Impulsive
6	S6	11,39	1,27	Fast - Accurate
7	S7	13,47	1,77	Fast - Accurate
Max Value	37,21	3,43		
Min Value	11,39	1,27		
Median	13,75	1,77		

Information: *time (t) in seconds*

This cognitive style test was conducted on seven students of grade IX in SMP, two students from SMPN 1 Ciawi, two students from SMPN 3 South Tangerang, one student from SMP Budi Mulia 2 Jogjakarta, and two students from SMPN 2 Kertahayu Ciamis.

TABLE 2. Student Thinking Process In Problem Solving

Stage	Aspects	Indicator
Entry	Know	(1) Understand the problem well
		(2) Finding what is known and what was asked in the questions
	Want	(3) Want to group and sort information
		(4) Want to solve the problem
	Introduce	(5) Create a mathematical model/symbol of the problem
		(6) Compile what is known from the problem
Attack	Try	(7) Submit an alleged solution to the problem solving
		(8) Modifying wrong guesses in order to be true
	Maybe	(9) Try the guess that has been made whether or not to solve the problem
	Why	(10) Have a logical reason for accepting or rejecting an allegation.
		(11) Reassure others that each step of settlement is done correctly orally or in writing through a systematic solution
Review	Check	(12) Check the accuracy of the calculation
		(13) Check the accuracy of the reason for the completion step
		(14) Check the suitability of the complete step with the question
	Reflect	(15)Reflect on the settlement's idea, which parts are difficult, and what can be learned from the settlement done
		(16) Reflecting temporary conjectures
	Extend	(17) Create a common form of the result obtained so that it can be used in a broader context.
		(18) Find another way to solve it
		(19) Trying to solve similar problems with changes in facts and things to ask

Adapted from: *Thinking Mathematically, Mason. J et, all. (2010)*

Determination of cognitive style is calculated based on the median time data (t) and frequency data (f) in answering the correct answer. From the table above, the results of measuring cognitive style show that two students have a reflective cognitive style, two students have an impulsive cognitive style, one student is slow - inaccurate, and two students are fast - accurate. According to Rozencwajg and Corroyer (2005), reflective cognitive style - impulsive as a characteristic of a cognitive system that combines decision-making time and work (performance) in solving problems containing a high

level of uncertainty. Two students who have a reflective cognitive style and two students with an impulsive cognitive style are selected. Then, they identify their thinking processes in solving mathematical literacy problems.

The mathematical literacy test is in the form of a description, which refers to the PISA test with personal context, quantity content, reflection process, and level 3 PISA. This test has previously been tested for the validity of the instrument. After working on questions, interviews were conducted with students to find out in-depth the description of students' thinking processes in solving mathematical literacy questions. The thinking process indicator is viewed from the three stages of problem-solving from Mason et al. (2010), namely entry, attack, and review.

2.1 Reflective Student Thinking Process (S2 and S3)

In general, S2 and S3 students have relatively the same thinking process in solving mathematical literacy problems. Almost all stages of the thinking process are well passed. Students can understand the problem at the entry stage, organize information, and know what to solve from the problem. This means being able to go through the know, want, and introduce stages. At the knowing stage, the students wrote down the known data in the form of the number of martabak bought by Mr. Andi, 200 mini martabaks, and a comparison of three martabak flavors chocolate, cheese, and matcha (1: 3: 4). Following are the answers are given by S2 students:

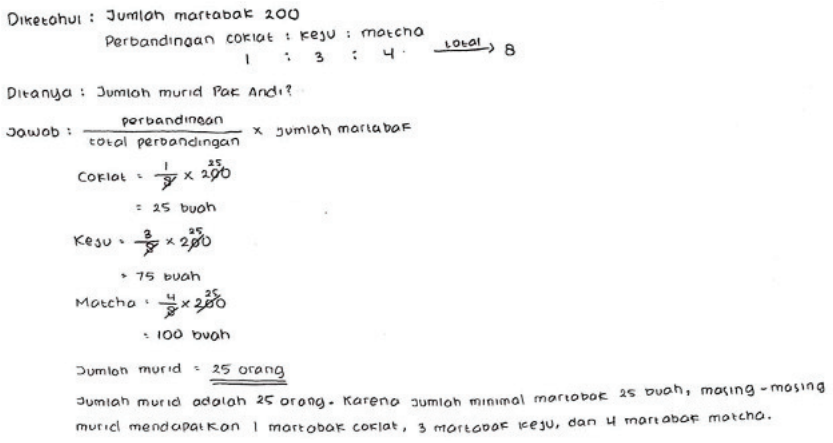

FIGURE 1. Students' Answers with Reflective Cognitive Style (S2)

Students also wrote down what was asked, namely how many students Pak Andi had. Students expressed a strong desire to solve mathematical literacy problems at the want stage, and in the introduction stage, students were able

to make mathematical models from the questions given. Students add up all the comparisons as a reference to determine the number of students from each comparison. At the attack stage, S2 students can pass the try, maybe, and why step. Meanwhile, S3 students are not able to do why to step well. At this stage, S3 students are not convincing enough when asked to explain how to obtain the possible number of students based on the comparison given. In contrast to S2, students can make a mathematical model of getting the possible number of students based on the comparison given, namely Comparison/(total comparison) $\times$ number of martabak. This stage requires creativity to be able to determine the right way to solve the problem. According to Orton (1992), the planning stage of problem-solving requires creativity, discovery, and deep understanding.

Based on the mathematical model made, S2 students were able to determine the possible number of Pak Andi's students based on available comparisons. The results obtained were 25, 75, and 100, respectively. This stage is an important stage for students to pass because it will determine how the next problem-solving process will be. The key to a problem-solving process lies in the idea of developing a resolution strategy. As Polya (1973) said, the ability to solve problems lies in the concept of planning. Then the S2 students concludesqq ded an answer to the question posed that Mr. Andi's number of students was 25. This reason is based on the number of students who get chocolate martabak. S2 students do not use the FPB concept in determining the number of Pak Andi's students. S2 students answer using their understanding and logic to the question. To obtain clearer information on the thinking processes of S2 students, interviews were conducted. Some of the results of the interviews by researchers with S2 students are as follows:

Teacher : *What are you doing to understand this matter?*
S2 : *I read the questions slowly and determine what is known and what is asked in the questions*
Teacher : *How do you solve this problem?*
S2 : *I first wrote down the method or general formula for obtaining the number of students based on the comparison given*
Teacher : *Then, why did you decide that the number of students was 25, not 75 or 100? What concept are you using?*
S2 : *Yes, if you choose the number of students 75 and 100, that's not possible, because the ratio is 1: 3: 4.*
Teacher : *Indeed, what happens if there are 75 students?*
S2 : *Yes, the results will not match the data in the question Sir, if the number of students is 75 with a ratio of 1: 3: 4, it means that the number of students who*

get martabak with chocolate taste 75, cheese flavor mmmm ... 75 x 3 is 225 and matcha taste 75 x 4 equal to 300.
Teacher : *Okay. Is there any other way to solve this problem?*
S2 : *Emm... maybe there is, Sir, but I'm not sure*
Teacher : *What are the concepts?*
S2 : *Emm.... I think FPB or KPK Sir ...? he ... (asked back)*
Teacher : *If, for example, the ratio of the question is changed to 2: 5: x and the number of matcha-flavored martabak is 60, what is the value of x?*
S2 : *Oh, if that's easy, Sir, just put the comparison into the general form I have made, SirSir. So that the x value is 3. So the ratio is 2: 5: 3*

Students are required to solve problems at the review stage by using ideas obtained from experience. S2 students cannot provide alternative solutions to solving problems. S2 students do not fully know that the way to solve these problems is with the FPB concept even though the method they do is in principle the same, and the results are also correct. For S3 students, the entry-stage can be passed quite well. Although seen from the students' written answers, S3 wrote down what was known from the questions, but it was not complete. S3 students do not write down the comparison of martabak taste that Mr. Andi will share. However, from the interview results, it was confirmed that S3 students understood the comparison of the taste of martabak but forgot to write it down on the answer sheet. At the Attack stage, there is a process that cannot be followed by S3 students, namely convincing others that every step of the completion is correct through a systematic solution. This can be seen from the arguments developed by S3 students in making conclusions that are not too strong. The reason is given why the answer to the number of students is 25 because there are 25 chocolate martabak in total. When asked why 25? S3 students are not too sure about the answer. Here are some excerpts from interviews with S3 students.
Teacher : *What do you do to understand this question?*
S3 : *I read the question first pack up to 3 times, next write down what is known and what is asked*
Teacher : *That many must be up to three times?*
S3 : *Yes, Sir, I like to understand when reading questions one time directly. Letten more stories like this. I want to read many times until meaning Mr.*
Teacher: *How do you solve this?*
S3 : *I first look for the amount of dignity for the ratio 1, 3 and 4*
Teacher : *How do I do that?*
S3 : *The method is only 1/8 x 200, 3/8 x 200, and 4/8 x 200*

Teacher : *Keep?*
S3 : *Yes, I'm sorry. The results will be 25, 75, and 100. Thus I choose 25 that's the number of students Mr. Andi*
Teacher : *Why did you decide the number of Mr. Andi students was 25 people, not 75 or 100 people?*
S3 : *Yes, because that's the least of the comparisons, Sir, If that results in 75 and 100, I don't think that's possible*
Teacher : *What concepts do you use?*
S3 : *It's using logic only Sir, he .... (laughing)*
Teacher : *That answer, did you check again? Who knows what's wrong.*
S3 : *No, Sir, it seems it's true*
Teacher : *Do you think there's no other way to solve this?*
S3 : *There's no, Sir. Enough use logic only*
Teacher : *If, for example, the problem's comparison is changed to 2: 5: x and the number of martabak matcha taste is 60, what is the value of x?*
S3 : *Hmmm.... (seems to be thinking). Do not know Mr. he ... (laughing)*

2.2 Impulsive Student Thinking Process (S4 and S5)

In solving mathematical literacy problems, the time spent by students S4 and S5 is faster than reflective students. Impulsive students tend to be in a hurry to answer questions, seem to want to solve them immediately, so they are not mature enough to develop a solution strategy. Warli (2009) states that impulsive students do not plan to solve problems carefully, so that many mistakes are found. This also happened to students S4 and S5, both of their answers in solving mathematical literacy questions were less accurate.At the Entry stage, S4 students go through all the know and want steps. However, at the introduce stage, there was one process that S4 students did not go through, namely not making a mathematical model of the problem.

In the Attack stage, S4 students have passed the try and maybe thought process stage. Students have made guesses from solving the problem. It can be seen that student S4 has determined how many martabak numbers are based on the given comparison. Then the results are used to solve the problem. However, the answers provided by student S4 were not quite right. S4 students are not able to explain every step of completion is done correctly and systematically. At the review stage, S4 students only do one process, namely, check. Students have studied the calculation only at the stage of finding the number of martabak based on the given comparison. Decision making in response to the questions being asked is still inaccurate. Student S4 answered Mr. Andi's

number of students by adding up all the numbers of martabak according to the ratio so that the answer to 200 was the same as the number of martabak that Mr. Andi bought. It can be seen that S4 students are not good at developing strategies for solving these problems.The following is the answer from student S4:

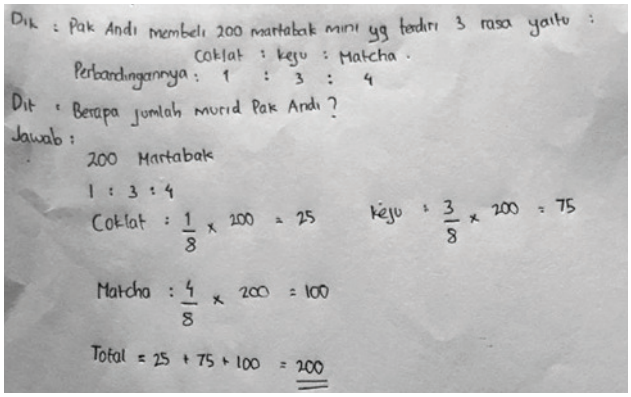

FIGURE 2. Students Answer with Impulsive Cognitive Style (S4)

In the last stage of the thinking process, namely review, S4 students were unable to go through all the thinking processes of reflecting and extending. Students cannot reflect on the problem-solving process and make general forms to be used in different situations. S4 students also do not have alternative solutions to the problems given. The following is a snippet of the results of interviews with S4 students: Teacher : *What are you doing to understand this matter?*
S4 : *I read these questions and wrote down what was known and what was asked.*
Teacher : *Tell me what the meaning of this matter is?*
S4 : *Yes, Sir, this question wants to find the number of Mr. Andi's students, knowing that 200 mini martabak with the ratio of chocolate, cheese, matcha martabak flavors is 1: 3: 4.*
Teacher : *Then how do you solve this problem?*
S4 : *I've solved a problem like this Sir*
Teacher : *Yes, how do you do it?*
S4 : *At that time, I worked on each comparison divided by the number of comparisons multiplied by the number of goods, Sir. So I looked for each of those comparisons.*
Teacher : *So how many students are Pak Andi?*
S4 : *There are 200 Sir*
Teacher : *Why 200? Is that the number of martabak that Mr. Andi bought?*

S4 : *There are 200 Sir*
Teacher : *So how many students are Pak Andi?*
S4 : *Oh, yes, yes Sir. I'm so confused Sir, he... (laughing)*
Teacher : *Then, what do you think the correct answer is?*
S4 : *What is it, Sir? I don't know, but maybe that's it Sir, in my opinion, 200*

The location of the mistakes made by S4 students was their inability to formulate a settlement strategy because S4 students tended to rush in solving problems. According to McKinney (1975), students impulsively process the information on tasks or problems less efficiently than reflective children and do less systematic or less put forward strategies. Warli (2009) found that impulsive students solve problems holistically. Lack of accuracy in doing (a little bit of trial and error), do it right away, so the answers tend to be wrong.

The thinking process of student S5 in solving mathematical literacy questions is almost the same as the thinking process of student S4. The difference lies in the try and why stages. At the try stage, S5 students were unable to modify the wrong guess to make it right. This resulted in S5 students being unable to pass the why stage, which is the stage of checking the reasons' accuracy in the completion step. Following are the results of interviews with S5 students:
Teacher : *Do you know how to solve this problem?*
S5 : *I first write what you know and what you ask*
Teacher : *How do you solve this problem?*
S5 : *Counting a lot of martabak according to comparison Sir.*
Teacher : *What formula are you using?*
S5 : *That's just a comparison, Sir, first, adds up all the comparisons and then looks for the number of martabak according to the comparison*
Teacher : *So the final result, how many students are Mr. Andi?*
S5 : *There are 200 Sir*
Teacher : *How come 200? isn't that the amount of martabak that Mr. Andi bought?*
S5 : *Yes, yes Sir, same*
Teacher : *If that is the case, the number of martabak is 200, then the number of students is 200, the ratio of the taste of the martabak is 1: 1: 1?*
S5: *Yes, yes, Sir, that means I was wrong (hmmm ...)*
Teacher : *So, what should be the solution to this problem?*
S5 : *Ehmm ... (students look confused)*

Based on the students' answers in solving mathematical literacy questions and the results of interviews with students S4 and S5, it was found that the

review thinking process still constrained the two students, namely reflect and extend. There was also a problem at the attack stage, namely why, at the entry, namely introduce. Especially for S5 students, they still have problems at the try stage, which is related to the presumption of solving the problems made.

Based on the above results, the reflective and impulsive cognitive style thinking processes are different in solving mathematical literacy problems. S2 and S3 students who have a reflective cognitive style are still constrained by the extend process.The following is a cognitive map of students who have a reflective cognitive style (S2 and S3) and students who have an impulsive cognitive style (S4 and S5):

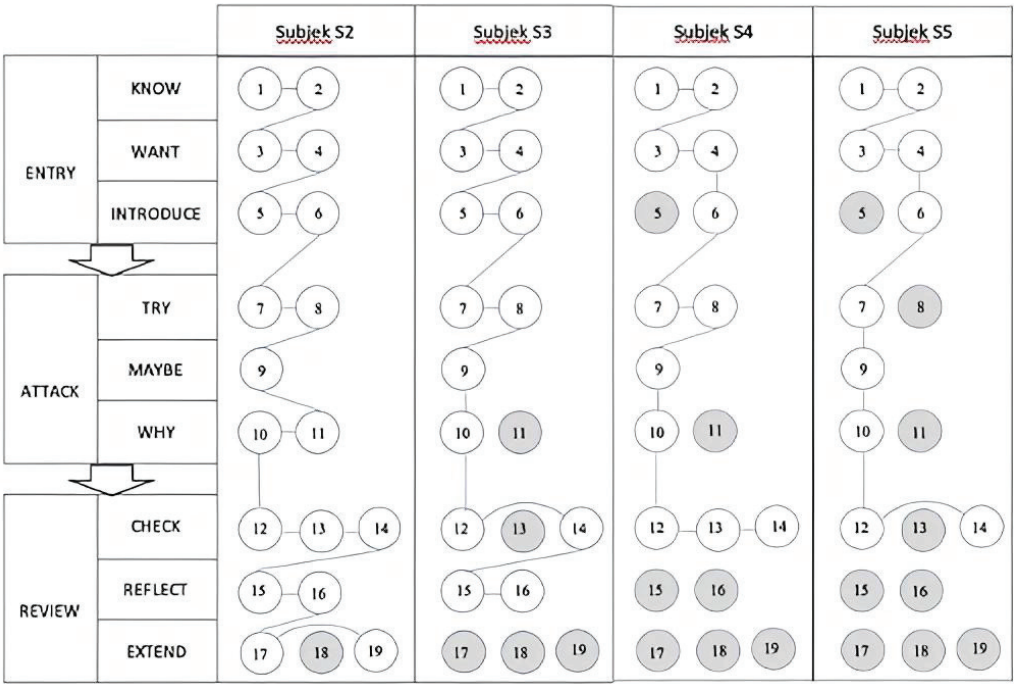

FIGURE 3. Cognitive Maps of Reflective (S2, S3) And Impulsive Students (S4, S5) In Solving Mathematical Literacy Problems

Students have not been able to make general forms of the results obtained so that they can be used in a broader context and use other ways to solve problems. Students S4 and S5 who have impulsive cognitive style, both of them still experience problems at the reflect and extend stages. Students cannot reflect on their ideas in solving problems and cannot generalize and find solutions to problems in other ways. Students with a reflective cognitive style tend to be able to solve problems well and spend a long time solving mathematical literacy problems, but the results obtained can be justified. Meanwhile, students

who have an impulsive cognitive style tend to rush in answering mathematical literacy questions and do not ensure that they understand the problem well. The problem-solving strategies used lack logical reasons, resulting in incorrect answers.

3. Conclusion

The components of mathematical literacy, namely context, content, and competence, are essential for students. Mathematical literacy problems require students to be able to solve problems by understanding the existing context, have sufficient understanding of the content related to the problem to be solved, and have the competence to be able to solve these problems well.

The student's thinking process phase goes through three stages, namely entry, attack, and review. Almost all phases were passed by students who had a reflective cognitive style, only one sub-phase had not been given, namely looking for other ways to solve problems. Students are not used to having alternative strategies for solving problems. However, they try to solve it by relying on their logic regarding the problem at hand. Students with a reflective cognitive style are more careful and tend to be cautious in solving problems. Students' thought process with impulsive cognitive style did not reach the review phase, especially in the reflect and extend phase. Students must reflect on their ideas and ideas in solving problems, making generalizations, and having alternative solutions to solve problems in this phase.

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