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Primary School Students' Computational Thinking in Solving Mathematics Problems Based on Learning Style

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abstract

Computational thinking is related to the ability to solve mathematical problems. This study aims to describe the computational thinking of primary school students with visual, auditory, and kinesthetic learning styles in solving mathematical problems as measured by indicators of abstraction, decomposition, algorithmic thinking, and generalization. This research is descriptive qualitative research. Data collection techniques using questionnaires, assignments, and interviews. Data analysis techniques using technical triangulation. The results showed that the computational thinking of students with visual and auditory learning styles fulfills all indicators of every aspect of computational thinking. Both identify important information by mentioning known and asked information, making mathematical models, solving problems by breaking them down into several parts, and solving them to get the right results. Both provide logical arguments regarding the method used, generalize the problem and apply the solution to similar problems. The difference lies in the mathematical form created. The mathematical form made by visual learning styles is more complete than auditory learning styles. This causes the settlement steps to also be different. Meanwhile, kinesthetic learning styles make mistakes when understanding the problem and making mathematical models, so the completion steps and the final results obtained are not appropriate. So, students need to get used to solving problems that can train their computational thinking skills so that students will get used to thinking systematically and logically.

Keywords:
Computational Thinking, Mathematical Problems, Learning Styles.

INTRODUCTION

One of the topics that are currently being discussed in the era of society is 5.0. The era of society 5.0 is a continuation of the era of society 4.0. The era of society 4.0 is closely related to technology, which is an industrial era that combines cyber technology and automatic technology. The combined technologies include physical cyber systems, cloud computing, and cognitive computing. The physical cyber system is a system related to the connectivity of devices in physical form with the internet network. Cloud computing is a combination of internet network-based development with computer technology (computing). Meanwhile, cognitive computing is the replication of individual thoughts into computed models and forms. This cognitive computing aims to develop an IT system that can solve problems automatically without individual assistance. Therefore, cognitive computing is used in artificial intelligence applications. The paradigm of progress in society 4.0 has resulted in extraordinary rapid technological growth and has had a tremendous impact on human society. Complexity, ambiguity, and imbalance have prompted the emergence of a new era called the era of society 5.0 which was spearheaded by the Japanese government. In contrast to the era of society 4.0, which places more emphasis on artificial intelligence, the era of society 5.0 places more emphasis on humans as its main component. Humans, as the main component in the era of society 5.0, are expected to create a balance of economic progress and solve social problems both in physical space and virtual space. Therefore, the ability to think critically, creatively, and systematically, and the ability to solve complex problems is needed and is a top priority to welcome the era of society 5.0.

To welcome the era of society 5.0, education as the front line must be able to contribute to changes in human civilization. Therefore, education must be able to develop the skills needed to meet society in the 5.0 era. One of the abilities that must be developed is the ability to think computationally (CT) (OECD, 2019; Haseski et al., 2018). The ability to think is one of the prerequisite skills needed in the 21st century and era 5.0 society (OECD, 2019; Haseski et al., 2018).

Thinking ability is thinking ability related to the mindset that includes the understanding of the problem-solving, level of abstraction, and development of automatic problem-solving (Bilbao et al. (2017). Thinking is a crucial approach in developing computer applications, but computational thinking can also be used to solve mathematical problems. This is in line with Rich et al., (2020) statement that thinking skills are used to apply mathematics learning. However, in reality, most of the mathematics learning processes in Indonesia cannot yet think about computing. It is as stated by Mufidah (2018) that students' computational thinking skills are still and must be maximized.

To develop computational thinking in solving mathematical problems, students need to be given mathematical problems that accommodate computational thinking abilities. The indicators of thinking are abstraction, decomposition, algorithmic thinking, and generalization (Bocconi et al., 2016). Abstraction relates to the ability to make problems easier and reduce complexity by focusing on important information and unimportant details. Decomposition is related to the ability to break down problems into smaller problems. Positive thinking with problem-solving using logistical steps. Generalization relates to the ability to identify patterns and adapt solutions so that they can be applied to similar problems. Based on the four assessments, one of the materials in primary school that can accommodate computational thinking skills is material. Material is material that can allow students to explore concepts, develop and use computational thinking skills, and cultivate mathematical thinking habits.

The thinking ability of each student is different in preparing students' readiness to accept and manage the material provided. Students' habits in receiving, compiling, and managing materials are referred to as learning styles (Fadly, 2021). Learning styles are often with learning modalities. Teachers as educators must be able to identify student learning modalities so that the teaching and learning process will be carried out effectively and pleasantly. Teachers who know the learning styles/learning modalities of their students will be able to organize classes well and meet student needs (Argarini, 2018). According to DePorter & Hernacki (Argarini, 2018), learning modalities are classified into three, which include visual, auditory, and kinesthetic. Visual modality can learn maximally by using the sense of sight, auditory modality can receive maximum learning by using the sense of hearing and kinesthetic modality can receive maximum learning by using the sense of touch or by touching and doing a lot of movements.

Based on the results of Mufidah's research (2018), the computational thinking ability of students who have different bits of intelligence is proven to have different problem-solving abilities and computational thinking abilities. Meanwhile, Danindra & Masriyah (2020) and Harmini (2020) also stated that the computational thinking abilities of students of different genders are also different. On another occasion, Argarini (2018) and Umrana et al. (2019) found that students who have different learning styles have different problem-solving abilities. This is supported by the statements of Bosman & Schulze (2018) and Nurdiana et al. (2021) that learning styles/learning modalities are correlated with solving mathematical problems. Each learning style can solve mathematical problems with different thinking abilities. Therefore, further studies are needed to describe the computational thinking of primary school students in solving math problems when viewed based on learning styles. This is needed so that later teachers and students can find out how far the students' computational thinking ability in solving mathematical problems is. In addition, it can also be used as a guide to creating a teaching and learning process that leads to computational thinking by considering students' learning styles.

THEORETICAL FRAMEWORKS

Computational thinking has received the attention of researchers since Wing's research on Computational thinking is a cognitive process that involves computational components to solve complex problems with or without the use of computers (NRC, 2010). CSTA & ISTE (2011) propose several components of computational thinking, which include data collection, data analysis, data representation, problem decomposition, abstraction, algorithms and procedures, automation, simulation, and parallelization. On another occasion, Selby and Woollard (2013) also reviewed the definition of computational thinking as a thinking process that describes five components, which include abstraction, algorithmic thinking, decomposition, evaluation, and generalization. Meanwhile, Bocconi et al. (2016) in their latest report have briefly described the key components of computational thinking in education, which consist of abstraction, algorithmic thinking, automation, debugging, decomposition, and generalization.

Based on several components that have been proposed, the components of computational thinking used in this research are abstraction, decomposition, algorithmic thinking, and generalization. The indicators of computational thinking are presented in Table 1.

Table 1. Computational Thinking Indicators

No.	Computational Thinking Aspect	Competency Indicators
1.	Abstraction	1.1 Identify important information about a problem
		1.2 Determining the mathematical model of a problem
2.	Decomposition	2.1 Breaking down the problem into sub-problems
		2.2 Solving sub-problems
3.	Algorithmic Thinking	3.1 Explaining logical steps to solve problems
		3.2 Finding a solution through the logical steps used
4.	Generalization	4.1 Determine the pattern of the given problem
		4.2 Adapting solutions to solve new problems aligned

METHODS

This research is a qualitative descriptive study. This research was conducted at one of the primary schools in Bojonegoro on 22-26 February 2022. The instruments used were the researchers themselves, learning style questionnaires, math problem tests, and interview guidelines. Meanwhile, the data collection technique was carried out through the questionnaire method, the assignment method, and the interview method. The subjects in this study were three fifth-grade students. The selection of students was based on several considerations, namely (1) visual, auditory, and kinesthetic learning styles; (2) relatively balanced mathematical ability; and (3) good communication skills. After obtaining the research subjects through the learning style questionnaire method, followed by the assignment method in the form of giving math problems tests and interview methods. Both methods were applied to the three research subjects to find out the students' computational thinking ability in solving mathematical problems. The data analysis technique is carried out using the Miles and Huberman model (Bungin, 2015) which includes data reduction, data presentation, and conclusion. The credibility of the data was tested by using triangulation techniques, namely by using mathematical problem test techniques and interview techniques. In addition, credibility testing is also carried out by increasing the persistence of observations and reviewing appropriate references.

RESULT AND DISCUSSION

Based on research conducted by the three research subjects consisting of students with visual, auditory, and kinetic learning styles. The following are the results of the math problem test, the results of interviews, data reduction, and research observations.

Figure 1. Students' Written Answers Visual Learning Style

In the abstraction aspect, students with visual learning styles identify important information by mentioning what is known and developed in detail and complete. The information is not only mentioned by repeating what is in the question but is explained in its language. In addition, the student mentions the mathematical model and explains the reason for the formation of the mathematical model. The student explains the reason why two numbers must be multiplied and subtracted.

In the aspect of decomposition, students with visual learning styles perform decomposition by dividing the problem into several parts. The first part calculates the entire supply of liquid milk. In the second part, the student counted the milk consumed for three days. In the third part, the student counted the milk consumed for seven days.

In the aspect of algorithmic thinking, students with visual learning styles complete the first step, which is to calculate the entire supply of liquid milk by multiplying $\frac{1}{5}$ liter and 35 bottles. The second step is to calculate the milk consumed for three days. The third step is to find the remaining milk supply by subtracting $\frac{35}{5}$ and $\frac{3}{2}$. The fourth step, divide $\frac{55}{10}$ by $\frac{1}{5}$ to find how many bottles of milk are left. The final result for question a is $\frac{55}{2}$or 27,5. In question b, students with visual learning styles count $\frac{1}{5} \times \frac{35}{1} = \frac{35}{5}$ as in question a, then the next step is to calculate the milk consumed for one week. The next step is to find the remaining milk supply by subtracting $\frac{35}{5}$ and $\frac{7}{2}$. In the final step, divide $\frac{35}{10}$ by $\frac{1}{5}$ to find how many bottles are left. The final result for question b is $\frac{35}{2}$ or 17,5.

In the generalization aspect, students with visual learning styles find patterns in the questions. They concluded that the more the day's supply, the less and the more milk consumed, but there was always $\frac{1}{2}$ liter. In addition, the student also applies the method used on similar questions. This question, in question c. When students with visual learning styles find similar questions, these students do not think about the steps to solve them from the beginning but only adapt the mathematical model and the steps used in questions a and b.

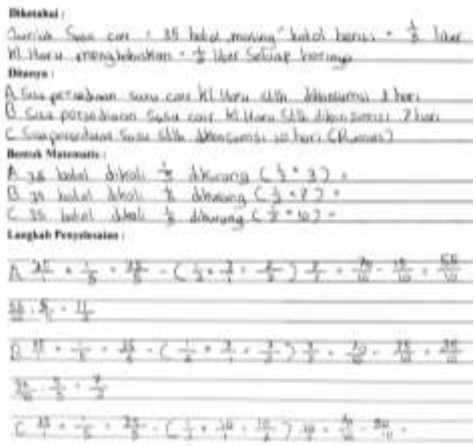

Figure 2. Students' Written Answers Auditory Learning Style

In the abstraction aspect, students with auditory learning styles identify important information by mentioning what is known and is asked in detail and clearly. The information is explained fluently using their language. In addition, the student determines a mathematical model and explains the reason for the formation of the mathematical model, namely by utilizing all the important information in the question and understanding the sentences contained in the question that if there is a statement of the amount of milk supply, the number of bottles and the size of the bottle must be multiplied, the amount of milk consumption per day and the number of days must be multiplied. If there is a residual statement, it must be subtracted.

Students with auditory learning styles perform decomposition by dividing the problem into several parts. In the first part, students with auditory learning styles count the entire supply of liquid milk by multiplying 35 bottles by the contents of each bottle, which is $\frac{1}{5}$ liter. In the second part (question a), students with auditory learning styles count the liquid milk consumed for three days. In the third part (question b), students with auditory learning styles count the liquid milk consumed for seven days.

In the aspect of algorithmic thinking, students with auditory learning styles solve problems with the first step, namely calculating the entire supply of liquid milk by multiplying 35 bottles by $\frac{1}{5}$ liter. The second step is to calculate the liquid milk consumed for three days. The third step is to find the remaining liquid milk supply by subtracting $\frac{35}{5}$ and $\frac{3}{2}$ to get $\frac{55}{10}$. In question b, the student calculates $\frac{35}{1} \times \frac{1}{5} = \frac{35}{5}$ as in question a, then the next step is to calculate the liquid milk consumed for one week or seven days. In the last step, students with auditory learning styles look for the remaining supply of liquid milk by subtracting $\frac{35}{5}$ and $\frac{7}{2}$ to get $\frac{35}{10}$.

In the generalization aspect, students with auditory learning styles find patterns and similarities in the questions. The student concluded that the more the number of days, the more milk consumed will be because every day the milk consumed always increases by $\frac{1}{2}$ liter. In addition, students with auditory learning styles can also apply the method used on similar questions. In this case, in question c. When the student finds a similar problem, the student does not need to think about the solution steps from the beginning but only adapts the mathematical model and the steps used in questions a and b. Students with auditory learning styles use the same formula to solve problems c. The difference lies only in the number of days in question.

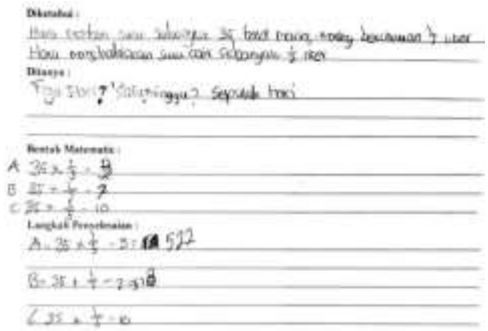

Figure 3. Students' Written Answers Kinesthetic Learning Style

In the abstraction aspect, students with kinesthetic learning styles identify important information by mentioning and explaining what is known and asked. Based on the results of the interview, the student stated that the liquid milk he consumed was $\frac{1}{2}$ liter without a description of the time spent for how many days. Through the researcher's questions, finally, the students stated that $\frac{1}{2}$ liter was spent every day without hesitation. The student mentioned the mathematical model and explained the reason for the formation of the mathematical model even though the mathematical model formed was not quite right. The student does not understand questions a and b because they think the description of questions and questions a and b are not separate. The students only focused on how many days the milk was consumed, without regard to how many liters of milk were consumed per day.

Students with kinesthetic learning styles perform decomposition by dividing the problem into several parts. In question a, a students with a kinesthetic learning styles calculate the entire supply of liquid milk by multiplying 35 bottles and $\frac{1}{5}$ liters and gets 525. The result of the student's multiplication is not quite right. This is due to the misconception of fractional arithmetic operations. By the mathematical model formed, students with kinesthetic learning styles assume daily milk consumption is 1 liter so that students immediately reduce the amount of milk supply by the number of days milk is consumed ($525 - 3 = 522$). This is also done when the student solves problem b. The student calculates $35 \times \frac{1}{5}$ and then reduces it by the integer 7.

In the aspect of algorithmic thinking, students with kinesthetic learning styles solve the problem with the first step, namely calculating the entire supply of liquid milk by multiplying the numbers 35 and $\frac{1}{5}$ and getting 525. The multiplication results obtained by these students are not quite right. This is due to a misconception. The second step is to find the remaining supply of liquid milk by subtracting the number 525 with the number 3 which results in 522. Due to the misconception of multiplication counting operations and lack of understanding, the final answer given by the student is not correct. In question b, students with kinesthetic learning styles use the same steps as in question a, which is to calculate $35 \times \frac{1}{5}$, then look for the remaining supply of liquid milk ($525 - 7 = 518$). As in question a, misconceptions about fractional operations and lack of understanding also occur when solving problem b.

In the aspect of generalization, students with kinesthetic learning styles did not find patterns in the questions. The pattern found is incorrect and the reasons given are illogical. The student stated that to solve the problem, multiply $35 \times \frac{1}{5}$ and subtract the number of days milk was consumed. The student adapts the method used in similar questions, in this question, which is on question c, but the adaptation method used is not appropriate.

Table 2. Differences in Students' Computational Thinking Ability Visual, Auditory, & Kinesthetic Learning Style

Aspect	**Students with visual learning styles**	**Students with auditory learning styles**	**Students with kinesthetic learning styles**
Abstraction	Identify important information by stating what is known and asked clearly and completely, and making mathematical models appropriate.	Identify important information by stating what is known and asked clearly and completely, and making mathematical models appropriate.	Identify important information by mentioning what is known and asked about the problem without understanding it, and not making an accurate mathematical model.
Decomposition	Break the problem into parts and complete the parts appropriately.	Break the problem into parts and complete the parts appropriately.	Breaking the problem into several parts, but the parts that are broken down are not quite right.
Algorithmic Thinking	State and explain the completion steps in detail and	State and explain the completion steps in detail and	Mention and explain the completion steps,

Aspect	Students with visual learning styles	Students with auditory learning styles	Students with kinesthetic learning styles
	in full and find the right solution based on the logical steps used.	clarity and find the right solution based on the logical steps used.	but the steps used are not correct and the results found are not correct.
Generalization	Finding patterns in problems and adapting solutions to problems that align appropriately.	Finding patterns in problems and adapting solutions to problems that align appropriately.	Not finding patterns and similarities in problems and not adapting solutions to problems that are aligned.

Based on Table 2, the computational thinking ability in the abstraction aspect of students' visual and auditory learning styles is almost the same, namely identifying important information by stating what is known and asked clearly and completely, and making mathematical models correctly. The difference lies in the mathematical model made. Students with visual learning styles make a more complete mathematical model than students with auditory learning styles, even though the mathematical model made by auditory students is correct. This is in line with the statement of Sulisawati et al. (2019) & Setiana et al. (2020) that students with visual learning styles are more detailed, thorough and write complete answers. Even so, students with auditory learning styles are superior in explaining their understanding in oral form. This agrees with DePorter and Henarcki (Argarini, 2018) that students with auditory learning styles are good at speaking, dialogue, and explaining. Meanwhile, students with kinesthetic learning styles only mention important information by repeating sentences in the questions and they are incomplete and do not make mathematical models correctly. This is because students with kinesthetic learning styles have difficulty understanding questions and making mathematical models (Soleha et al., 2019). The way students understand problems and create mathematical models is related to reasoning abilities. According to the research results of Haryono & Tanujaya (2018), the reasoning ability of students with kinesthetic learning styles is not better than visual and students with auditory learning styles.

Students with visual and auditory learning styles perform decomposition by breaking the problem into several parts and solving the parts correctly. Meanwhile, students with kinesthetic learning styles break the problem into several parts, but due to the inaccuracy of the mathematical model formed, the parts that are broken down are also inaccurate. Solving the problem in several ways is one form of problem planning. Making a mathematical model correctly and solving it by breaking it down into several parts is evidence that students with visual and auditory learning styles understand problems well and plan problems well. This is in line with the statements of Indrawati (2017), Argarini (2018), and Umrana et al. (2019) that students with visual and auditory learning styles can understand problems, plan problems and solve problems well.

Meanwhile, students with kinesthetic learning styles do less precise planning. This is in line with the statement of Umrana et al. (2019) and Anggraini et al. (2021) that students with kinesthetic learning styles are less able to plan problem-solving.

As described by Argarini (2018) and Wulansari et al. (2019), students with visual and auditory learning styles solve problems well. This is directly proportional to the research results shown in Table 2, where students with visual and auditory learning styles mention and explain the completion steps in detail and in full and find the right solution based on the logical steps used. Meanwhile, students with kinesthetic learning styles mention and explain the completion steps, but the steps used are not appropriate due to a lack of understanding, errors in mathematical models, and misconceptions about fractional arithmetic operations. Therefore, the final results found by students with kinesthetic learning styles are not appropriate.

In the generalization aspect, students with visual and auditory learning styles find patterns and adapt solutions to similar problems appropriately. This agrees with Firdaus & Rustina (2019) that students with visual learning styles can generalize a problem. Meanwhile, students with kinesthetic learning styles did not find patterns and did not adapt solutions to similar problems. Based on this description, the computational thinking ability of students with visual and auditory learning styles is almost the same. That is, they both fulfill all indicators of every aspect of computational thinking. Only the mathematical model and completion steps used are given by students with a more complete visual learning style. Meanwhile, students with kinesthetic learning styles make mistakes since they understand the problem and make mathematical models, so the completion steps and the final results obtained are not appropriate. This is in line with the research results of Willia et al. (2020) that the problem-solving ability of students with visual and auditory learning styles is as good, while the students with kinesthetic learning styles are not good enough because they have not been able to plan problem-solving and implement them appropriately. On another occasion, State et al. (2021) stated that the problem-solving ability of highly skilled students with visual learning styles was superior to students with auditory and kinesthetic learning styles. Students with inesthetic learning styles experience are higher misconceptions than students with visual learning styles (Mufidah & Budiarto, 2018).

CONCLUSION AND IMPLICATION

Based on the researcher's findings, it can be concluded that the computational thinking ability of students with visual and auditory learning styles fulfills all indicators of every aspect of computational thinking. Both identify important information by mentioning known and asked information, making mathematical models appropriately, solving problems by breaking them down into several parts, and then solving them to get the right results. In addition, both provide strong and logical arguments regarding the method used, generalize the problem and apply the solution to similar problems. The difference lies in the mathematical form created by visual and auditory learning styles. The mathematical form made by students with visual learning styles is more complete than the mathematical form made by students with auditory learning styles. This causes the settlement steps to also be different. The steps used by students with visual learning styles come to the acquisition of the remaining number of milk bottles. Meanwhile, the steps used by students with auditory learning styles only reach the number of liters of milk remaining. Even so, both answers are correct. And then, students with kinesthetic learning styles make mistakes when understanding the problem and making mathematical models, so the completion steps and the final results obtained are not appropriate.

The results showed that the thinking ability of each learning style was different. Teachers understand these differences so that they can realize the teaching and learning process by using techniques, strategies, methods, and learning models that can meet all learning styles. In addition, teachers often provide questions that can train students' computational thinking skills. Through this, it is expected that students will get used to thinking systematically and logistically. In addition, students' thinking skills with visual, auditory, and kinesthetic learning styles can be improved and balanced.

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