Analysis of Students Algebraic Thinking Ability viewed by Auditory Learning Style

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Abstract. This study aimed to find out an overview of students algebraic thinking abilities viewed by auditory learning styles in one of the junior high schools in Bandung. This research is motivated by the results of studies that show varying ability (high, medium, and low) of junior high school algebra, so it is necessary to know the cause, and one of the causes is learning style. The subjects in this study were three students with auditory learning style. This research used a qualitative method. The data was collected using: learning style questionnaire, essay test, interview, and documentation. The results show that students who have auditory learning styles tend to answer with explanations in the form of sentences so that they can clarify what they mean or what they understand. Students who have auditory learning styles are able to fulfill indicators in algebraic thinking skills: conceptually based on computational strategies, manipulating numbers and symbols using algebraic rules, and expressing generalizations of patterns and rules in real-world contexts. Based on this research, the researcher suggested that the students can be facilitated with appropriate learning methods or models to contribute well to their algebraic thinking abilities.

1. Introduction

Mathematics is a part of science that has an important role in life because mathematics underlies the human logic. Mathematics growing and developing based on the process of thinking so that mathematics is formed based on human logic [10]. Mathematics is one of the subjects in the school that plays a role in helping students develop their logic. Logic plays a role in the thinking process of students. Thinking is a mental activity that involves students' knowledge aimed at making decisions, seeking understanding, and solving problems [8][9]. These thinking activities must continue to be made in order to make a habit of thinking and expecting to be able to equip students to develop their thinking processes.

One component that is important to learn in mathematics is algebra. Algebra is one branch of mathematics that began formally studied by junior high school students. Algebraic concept begins with arithmetic as its basis. This is in accordance with what was stated by Clapham and James Nicholson argue that "algebra is the area of mathematics related to the general properties of arithmetic", which means that algebra is a field of mathematics related to the general properties of arithmetic [2]. In understanding algebra, students must have a good understanding of arithmetic. Students must be given an initial understanding of something concrete and then confronted with something abstract. If students immediately learn something abstract then students will find it difficult to understand it. In learning algebra, if students are not given initial understanding in the form of something concrete, namely arithmetic, then students will find it difficult to understand
algebra. Algebra is used to generalize arithmetic through letter symbols and certain signs, which makes algebra an abstract science[7].

It is seen that algebra is studied at middle school level so it must be mastered by students. Students need thinking skills, one of them is the ability to think algebraically. Algebraic thinking processes can be observed when students solve algebraic problems. The terms algebraic thinking or algebraic thinking appear as representations of activities or abilities in learning algebra in school. Herbert and Brown states that algebraic thinking is an exploration of information from various situations and represents mathematical information with words, diagrams, tables, graphs, and equations [4].

The importance of algebraic thinking is not in line with the achievement of students’ abilities in school. In fact many students have difficulty in applying and developing algebraic thinking. Based on the results of a preliminary study in one of the junior high schools in Bandung, students also still did not understand the meaning of variables and calculation of algebraic operations. Students are still having difficulty understanding algebraic expressions and applying arithmetic operations in numerical and algebraic expressions, this can be seen in the Figure 1 which is an example of student answers. Students are asked to determine the value of \( x \) in the equation \( x - 1 = 2x + 3 \).

The student's answer in Figure 1 shows an error in operate \(-x = 4\) was equal to 5. These student answers can indicate algebraic thinking skills was low. The results of several studies show the diversity of algebraic thinking skills. Angriani's research [1] and Nurhayati's research [6] show the achievement of each indicator of algebraic thinking of students who tend to be low and moderate. The diversity of learning outcomes is the result of activities during learning, one of which is the effect of learning in the classroom. Students have their own learning methods in the learning process known as learning styles. On students' algebraic thinking abilities there are effects of learning style in interpreting the results of their thinking. This study focuses on auditory learning styles. Learning style is a combination of how students absorb and organize and process information [3]. When absorbing information, students have a tendency with one of three learning style. According to DePorter & Hernacki students with auditory learning style rely on hearing to understand and remember something [3].

![Figure 1. Student answer](image.png)

2. Method

The subjects in this study were three students with auditory learning style based on learning style questionnaire from one of the junior high schools in Bandung. This research used a qualitative method. Data of algebraic thinking were collected using through learning style questionnaire, essay test, interview, and documentation. Furthermore, the data were analyzed with a descriptive way.

3. Result and Discussion

The indicators used in this study are conceptually based on computational strategies, manipulating numbers and symbols using algebraic rules, and expressing generalizations of patterns and rules in real-world contexts [5]. The following will discuss the student algebraic thinking ability viewed by auditory learning style.

3.1. Algebraic thinking ability in conceptually based on computational strategies indicator

Question number 1 is “A girl plays scale with her friend, they have 5 cylinders, 4 cubes, 4 cuboids and 4 balls. A cylinder weight is 75 grams, a cube weight is 50 grams, a ball weight is 125 grams and a cuboid weight is unknown.
Her friend think if she put 3 cylinders and a ball on right side, the scale will be balance. Is it right? Please Explain!

**Figure 2.** Student answer for number 1a with conceptually based computational strategies indicator

Figure 2 shows student’s answer, student can explain it but failed to calculate because student misunderstanding the problem. Student success to calculate on the left side (one ball, 2 cubes and 2 cylinders) but failed to calculate the weight on right side (3 cylinders and a ball). The calculation should be 350 grams not 225 grams. It was known from the interview that student was no careful in reading the questions. So, student can explained that the answer is wrong because the scale is not balance.

Researcher: You write 75 x 3 what do you mean?
Subject: I mean 75 is a cylinder weight then I multiply it by 3 because there are 3 cylinders
Researcher: Is it just 3 cylinders?
Subject: Oh.. I am wrong. It must be 3 cylinders and a ball

Question 1b is “a girl put her teddy bear the weight is 0.5 kg. How many cylinders, cubes, or balls can be placed to make the scale balance? Please explain!”

**Figure 3.** Student answer for number 1b with conceptually based computational strategies indicator

Figure 3 shows that student can understand the concept of use scale. The weight on right side equal to the weight on left side. Student put 4 cylinders and 4 cubes to make it balance. Student who has auditory learning style tend to answer with explanations in the form of sentences so that they can clarify what they mean or what they understand [3]. The following is the interview with a research subject.

Researcher: Do you understand what you wrote?
Subject: Yes, I do.
Researcher: How can you get 4 cylinders and 4 cubes?
Subject : I try one by one. When I put a cylinder, the weight must be easy to added another. I get 4 cylinders, \(4 \times 75 = 300\) grams and I need to get 200 grams so I put 4 cubes, \(4 \times 50 = 200\) grams.

Researcher : How about the conclusion?

Subject : So, the scale will be balance if I put 4 cylinders and 4 cubes.

Question 1c an equation is obtained by specifying a cuboid with a variable, the question is how much the weight of a cuboid if it is known that a ball and three cuboids are placed on the left scale?

![Figure 4](image-url)

**Figure 4.** Student answer for number 1c with conceptually based computational strategies indicator

The answer from figure 4 with conceptually based on computational strategies indicator. Student can understand the meaning of variable. Student make symbol \(n\) as a cuboid, but it’s wrong because it must be the weight of a cuboid not just a cuboid. Student can understand the concept of use scale. The weight on right side equal to the weight on left side. Equation is correct \(125 + 3n = 500\) and got right answer.

3.2. Algebraic thinking ability in manipulating numbers and symbols using algebraic rules indicator

Question number 2 is the parking lot can accommodate 96 cars and motorbikes. After counting parked cars and motorbikes, it is known there are 272 wheels parked. If the parking rate for motorbikes is Rp2,000,00 and for cars Rp3,000,00, please make a mathematical model and calculate how much money does the parking attendant receive?

![Figure 5](image-url)

**Figure 5.** Student answer for number 2 with manipulating numbers and symbols using algebraic rules indicator

Figure 5 shows student answer in manipulating numbers and symbols using algebraic rules. Student make symbol \(a\) as a car and \(b\) as a motorbikes but it’s wrong because it must be symbol \(a\) as number of car and symbol \(b\) as number of motorbikes. Student use elimination method to find the value of \(a\) and \(b\), got the value \(a = 40\) dan \(b = 56\). Then student make conclusion that the parking attendant gets money Rp232,000,00.

Researcher : Do you understand these symbols?

Subject : Yes, maam.

Researcher : Please explain it to me!
Subject : from the question I make two symbols, there are \( a \) as a car and \( b \) as a motorbike
Researcher : Can I change with other letters?
Subject : yes, you can.
Researcher : You got the answer Rp232,000.00, please explain it to me!
Subject : I make symbols and equations. I get value from variable \( a \) and \( b \) by using elimination method, value of \( a \) is 40 and \( b \) is 56. Because parking rate for motorbikes is Rp2,000.00 and for cars Rp3,000.00, so 
\[
40 \times 3,000 = 120,000 \quad \text{and} \quad 56 \times 2,000 = 112,000.
\]
The total is Rp232,000.00

3.3. Algebraic thinking ability in expressing generalizations of patterns and rules in real-world context indicator

Question number 4 is Mr. Rama wants to make tiles in his house with the pattern same to the pattern in the picture above.

a. How many tiles do you need in the seventh pattern?
b. How do I determine which tiles are needed in the pattern to-\( n \)?

Figure 6. Student answer for number 3a with expressing generalizations of patterns and rules in real-world context indicator

Figure 6 student can answer question number 3a, relate to answer 3b student be able to list the pattern. Student list pattern from first pattern until forth pattern and we know that each pattern multiplied by two. If we know how many tiles in seventh pattern, we must multiply \( 2 \times 7 = 14 \).

Furthermore, student is expected to answer how much the tiles needed on the \( n \)th pattern. The student answer is \( 2n \), which is correct. students explain how to get \( 2n \) results by writing first the patterns formed and then it appears that each pattern is multiplied by 2 so that \( 2n \) is obtained as shown. Students also get \( 2n \) based on the difference in the number of tiles per pattern which is 2 tiles. The following is the answer in Figure 7 and interview with a research subject

Figure 7. Student answer for number 3b with expressing generalizations of patterns and rules in real-world context indicator

Researcher : how can you get the answer is \( 2n \)?
Subject : I make list in each pattern so I know that every pattern multiplied by 2 so to get \( n \)th pattern I multiply 2 and \( n \). The answer is \( 2n \)
4. Conclusion

Based on the achievement of each indicator, it can be concluded that students’ algebraic thinking ability who have auditory learning styles are able to fulfill indicators in algebraic thinking skills: conceptually based on computational strategies, manipulating numbers and symbols using algebraic rules, and expressing generalizations of patterns and rules in real-world contexts. Student be able to meaning of variables and variables expression, make linear equation, and generalize the pattern. From result and discussion, it can be seen that most of the students in the picture above were able to explain to the details and also the student has a auditory learning style, which has a characteristic to explain until the details.

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6. References