Students’ Algebraic Reasoning In Solving Mathematical Problems With Adversity Quotient

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Abstract. Algebraic reasoning is a process in which students generalize mathematical ideas from a set of particular instances and express them in increasingly formal and age-appropriate ways. Using problem solving approach to develop algebraic reasoning of mathematics may enhance the long-term learning trajectory of the majority students. The purpose of this research was to describe the algebraic reasoning of quitter, camper, and climber junior high school students in solving mathematical problems. This research used qualitative descriptive method. Subjects were determined by purposive sampling. The technique of collecting data was done by task-based interviews. The results showed that the algebraic reasoning of three students in the process of pattern seeking by identifying the things that are known and asked in a similar way. But three students found the elements of pattern recognition in different ways or method. So, they are generalize the problem of pattern formation with different ways. The study of algebraic reasoning and problem solving can be a learning paradigm in the improve students’ knowledge and skills in algebra work. The goal is to help students’ improve academic competence, develop algebraic reasoning in problem solving.

1. Introduction

Reasoning in mathematics is a cognitive process of looking for a reasons and looking for conclusions [1]. Algebra is the way we express generalizations about numbers, quantities, relations and functions [2]. Algebraic thinking or reasoning involves forming generalizations from experiences with number and computation, formalizing these ideas with the use of meaningful symbol system, and exploring the concepts of pattern and function [3]. Problem is a gap or discrepancy between present state and future state or desired goal [4]. A problem is a situation that confronts the learner, that requires resolution, and for which the path to the answer is not immediately known.

AQ is the intelligence to withstand adversity [5]. Stoltz classifies three types of people related to Adversity Quotient (AQ), namely: The Quitter (low AQ), The Camper (moderate AQ), and The Climber (high AQ). Quitters are group of people with less eagerness to accept the challenge of life. Campers are type of people having enthusiasm to face the problems and challenges, but they terminate it due to their incapability. While climbers are people who keep surviving to strive against all sorts of things that will keep crashing, regardless it may be the problem, the challenge, and the obstacle, things that continue to occur every day.

More recently, researchers have begun to explore how reciprocal reasoning when solving equations [6], co-variational reasoning [7], algebraic generalisation strategies [8] and patterns as tools for algebraic reasoning [9]. However, since this research is in its junior high school, there are numerous unexplored
issues. The research questions are how to describe the algebraic reasoning of quitter, camper, and climber junior high school students in solving mathematical problems.

2. Method
The study was a qualitative research with a descriptive strategy. The participant of this research were the 8 grade students. Students were classified based on the AQ by using questionnaire. From each AQ category, participant were selected by purposive sampling to determine the students’ algebraic reasoning. The selection of research participant was performed by considering several criteria, namely: (1) the result of students’ writing test on participant selection, (2) the students’ communication skills (based on teacher’s suggestion in teaching and learning activities), and (3) the students’ AQ category. The data in this study was a task-based interviews.

The process of investigating algebraic reasoning consists of three phases: (1) pattern seeking; (2) pattern recognition and (3) generalization [8]. Three Indicator of algebraic reasoning in solving mathematical problem can be shown in table 1 as follows:

| Indicators      | Algebraic reasoning activity observed                                      |
|-----------------|---------------------------------------------------------------------------|
| pattern seeking | a. Students determine information as something that was known dan asked.  |
|                 | b. Students use multiple representations for known things                 |
|                 | c. Students finding the elements of the pattern.                          |
| pattern recognition | a. Students looking at relationships among the sequence has given          |
|                 | b. students discover the similarities relationship each constituent element of pattern |
| Generalization  | Students was using strategy of generalization pattern was choosen         |

3. Result and Discussion
Subjects with the quitter's category was performing of algebraic reasoning such as (1) pattern seeking; (2) pattern recognition and (3) generalization. subject with quitter's category was doing substitution a information that was known and the previous question to ensure that the answers found was correct. It was shown in the figure 1:

![Figure 1. Quitter’s answer sheet in explaining information](image)

Figure 2 demonstrates pattern recognition with given situations by experimented to observe relationships and similarities between elements pattern, quitter try to calculate with different numbers so as to find relationships between elements pattern. Quitter explain that in solved problems on text will still use the same pattern. Quitter performed pattern recognition in understanding mathematics problems. Although campers was less persistent in overcoming new things compared to climbers, yet they also possess willingness to try new things including to solve mathematics problems. Their experiences in solving mathematics problems make it easier for them to analyze information of a problem so that they will tend to engage pattern recognition in understanding mathematics problems.
After analyzed the image and finding the pattern formed, the quitter was able to formulate a general formula of the pattern. It was shown in the figure 3:

\[
\begin{align*}
& n \times q + 2 \\
& d_n + 2,
\end{align*}
\]

Figure 3. Quitter’s answer sheet in explaining generalization

Subsequently, camper's category was performing of algebraic reasoning such as (1) pattern seeking; (2) pattern recognition and (3) generalization. subject with camper's category was doing substitution a information that was known and the previous question to ensure that the answers found was correct. It was shown in the figure 4:

Figure 4. Camper’s answer sheet in pattern seeking

It appears that camper could describe the information in the was known and question at once by using camper’s own words. Figure 4 demonstrates the representations performed by the student by symbolizing the two inquired numbers with \( k \) and \( s \). Hence, in understanding mathematics problems, camper performed both abstraction. Figure 5 camper finds the elements of pattern by drawing cube rows.

Figure 5. Camper’s answer sheet in finds elements of pattern

Figure 5 demonstrates the camper pattern recognition finding relationships between elements of pattern constituents by observing patterns found previously and finds the similarity of relationships each element of pattern. Figure 6 was adjustment strategy to find the generalization formula and using that formula to determine the solving.
Subsequently, climber’s algebraic reasoning in solving mathematics problems was obtained through analysis and discussion similar to camper’s analysis and discussion. Camper's category was performing of algebraic reasoning such as (1) pattern seeking; (2) pattern recognition and (3) generalization. Figure 7 shows an example of climber’s answer sheet in explaining the information.

The climber in recognizing the patterns given situation by experimented to observe relationships between elements pattern. Climber finding the number of stickers needed on each number of cube rows by using the formula they find. Climber's realizes that there was a pattern similarity relationship so that in completing tasks use the same way.

The climber formulates a general formula of the pattern through analysis and general conclusion from the known. Using a climber image gives a description of the formula generalize. It was shown in the figure 10:
The result of algebraic reasoning in this study mostly confirmed the result of previous studies carried out by Istiqomah [10]. It of have studied the algebraic reasoning in senior high school grade in solving mathematics problem.

4. Conclusion
Several conclusion can be derived from the study on students algebraic reasoning based on Adversity Quotient as follows: 1) in pattern seeking quitter involved was substitution a information that was known and the previous question to ensure that the answers found was correct. In devised a plan of problem solved, climber included the pattern recognition and generalization the solution. 2) in pattern seeking , camper involved was substitution a information that was known and the previous question to ensure that the answers found was correct. In addition, camper also entailed abstraction to understand In planned problem solving, camper finds the elements of pattern by draw cube rows. In implementing the plan of problem solved, camper pattern recognition find relationships between elements of pattern constituents by observed patterns found previously and finds the similarity of relationships each element of pattern was adjustment strategy to find the generalization formula and used that formula to determine the solution. 3) In pattern seeking, climber involved was substitution a information that was known and the previous question to ensure that the answers found was correct, climber finds the elements of pattern by draw cube rows. In implementing the plan of problem solved, the climber formulates a general formula of the pattern through analysis and general conclusion from the known.

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