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STUDENTS'MATHEMATICAL PROBLEM SOLVING ABILITY BASED ON THE STEPS OF IDEAL PROBLEM SOLVING VIEWED FROM ADVERSITY QUOTIENT (AQ)

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Abstract

The ability of problem solving is one of essential mathematical abilities in learning mathematics. The facts in the field indicated that the problem solving ability of senior high school students were still low. Adversity Quotient (AQ) was presumed to play a role in the ability of students in solving problems. This research intended to describe the ability of students' mathematical problem solving in accordance with the steps of IDEAL problem solving viewed from their AQ. The participants were consisted of three students of grade XI in one senior high school in Banda Aceh. The research finding indicates that the problem solving abilities of the students using steps of IDEAL problem solving regarding their AQ are differ. The climber solved problems by using all the steps of IDEAL problem solving, the camper only did four steps, and the quitter did not do any of the steps in solving the problem.

INTRODUCTION

Problem solving is an essential mathematical ability for students to acquire in the mathematics subject. In doing problem solving, students need various thinking abilities, persistence and curiosity, as well as firm belief in dealing with uncommon situations, which can later become experience for their real life (NCTM, 2000). Moreover, problem solving makes students accustomed to creating ideas which can improve their flexibility in dealing with various problems (Dina, Amin, & Masriyah, 2018). Therefore, Contribution of this paper to the literature:

- This study examines in depth about how students' abilities in problem solving are based on each types of AQ.

- The results of work and student interviews in solving problems are evaluated according to the steps of IDEAL problem solving.
- The findings of this study indicate that difference of AQ level of students affects the way students solve the problems based on the steps of IDEAL problem solving.

It is generally accepted that the goal of instruction of mathematics is to make students a good problem solver (Pečiuliauskienė & Damauskienė, 2013; Schoenfeld, 2016).

The facts in the field show that the ability of students' mathematical problem solving was still low. Based on the PISA 2015 results, the score of Indonesian students' mathematical abilities is still at a low level. Indonesia obtained a score of 386 and it is still below the average score set by the OECD, which is 494 (OECD, 2016). The results also show that the problem solving abilities of Indonesian students are still in the low category. Based on the explanation presented by the OECD (2014), overall there were six levels of problem solving abilities measured in mathematics category of PISA tests in 2003, 2006 and 2009. However, based on the PISA 2015 results, only 0.8% of Indonesian students were able to answer questions at level 5 or 6 for at least one subject of all subjects, namely science, mathematics, and reading. Then, There are 42.3% of Indonesian students can answer questions below level 2 in all three subjects (OECD, 2016). The PISA results showed that the problem solving abilities of Indonesian students are still in the low category. Many students were unable to carry out all steps in solving problems (Santosa, Waluya, dan Sukestiyarno, 2013). It is in line with the result of the try-out on problem solving ability conducted in November 2016 in one school in Banda Aceh. The result of analysis indicated that the questions tested belonged to the category of very difficult, but the different capacity of the questions was good enough to differentiate the students with high proficiency from those with low proficiency.

The though process in the mind which occurs while students are doing problem solving will be affected by various obstacles so that every student has different abilities when dealing with problems. Therefore, AQ seems to play a role related to the students' ability in solving problems (Sahyar & Fitri, 2017). AQ is a quotient to survive in dealing with difficulty. Stolz (2000) defines AQ as one's quotient in facing and overcoming difficulty in a well-arranged way and can be an indicator to see how far one can survive in dealing with his/her problem. AQ divides human beings into three types, i.e. high AQ (climber), medium AQ (camper), and low AQ (quitter). The quitter learner is a type of learner who chooses to avoid problems and rejects an opportunity given. The camper learner is unwilling to take a high risk and easily feels content with the condition or situation which has been achieved. The climber learner makes considerable effort in order to solve problems. It was shown by the result of research by Suryadi and Santoso (2017) that the higher the learner's AQ, the better his/her academic achievement. The importance of the role of AQ in the learning process was also shown in the research conducted by Oliveros (2014) which indicates that there is a significant correlation between AQ level and students' ability in solving problems.

Previous studies have investigated the correlation between mathematical problem solving ability and AQ, but they gave more focus on looking at the thinking process of students in solving problem viewed from AQ (Fauziyah, Nur, & Usodo, 2013; Sari, Sutopo, & Aryuna, 2016; Yani, Ikhsan, & Marwan, 2016). Other research also focused on investigating the correlation between AQ and students' problem solving ability quantitatively, which

means that no research has so far been conducted to investigate the two variables more deeply (Oliveros, 2014). Thus, no research has more deeply studied students' mathematical problem solving ability viewed from AQ where the ability follows the steps of IDEAL problem solving.

Based on the research background elaborated above, the formulation of research problem in this present study is as the following: how is the students' mathematical problem solving ability based on the steps of IDEAL problem solving viewed from Adversity Quotient (AQ)?

METHODOLOGY

This research is explorative qualitative which was conducted in one school in the City of Banda Aceh. The selection of school was based on the result of the try-out done by the author on problem solving ability questions which indicated that the students' problem solving ability was still low. Furthermore, the selection of grade XI students was based on the reason that the students had learned quadratic equation when they were in second semester of grade X, which was the material investigated in this research. The material was selected because of its relation to material examined on try-out, namely one-variabel linear equation. The question of try-out done by the author to the grade XI student is shown below.

> In three consecutive days, Ridha spent money to buy school stuff. On Sundays he spent 1/2 of his money. On Monday, he spent Rp. 8,000 less than the money he spent on Sunday. While the money spent on Tuesday is only 1/2 of shopping on monday. Now her money is Rp. 2,000. Please make a mathematical model of the problem and determine Ridha's money before spending it.

Figure 1. The question of try-out

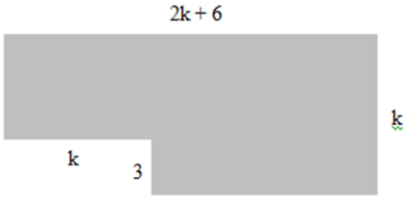
The research subjects consisted of three students from each of the three types of AQ, that is, one climber, one camper, and one quitter. The grouping of the students was based on the results of the students' answer to Adversity Response Profile (ARP) as well as other consideration that those students were able to communicate well in giving their opinions when they were interviewed.

The main research instrument was the researchers supported with other instruments, namely Adversity Response Profile (ARP), question items of mathematical problem solving and interview guideline. The ARP used in this research was adopted from the ARP of Stoltz (2000), Bennu (2012), and Yani, Ikhsan & Marwan (2016). The question items of mathematical problem solving and interview guideline were developed by the researchers. The questions that have been developed are then validated by four validator who are experts to this study. There are three aspects examined in validation, namely the construction of questions, language, and material. The revised items is then given to several students of XI (other than subjects) for doing readability test. The students must have a moderate or high mathematical abilities and have studied the material of quadratic equations. The results showed that the students can understand the intent of the problems and can work on the problems although at first there was confusion in understanding the problems. There are two question items of mathematical problem solving that was be used

in this research. The questions item of mathematical problem solving I were equivalent to the questions item of mathematical problem solving II because the indicator and level of difficulty are the same even though the context is different. As for the guideline interviews followed by the steps of problem solving are based on IDEAL problem solving and have been consulted with relevant experts. The question items of mathematical problem solving after revision are shown below.

Questions item of mathematical problem solving I

1. The distance of Hanif's house to the Baiturrahman Mosque is 2 km farther from Andi's house to the mosque. If the number of squares from the distance of Hanif and Andi's house to the mosque is 10 km. Please determine the distance of Hanif's house to the mosque!
2. Amir cuts one of the pieces of rectangular paper so that it looks like the figure below. The area of paper now is 35 cm². Please determine the value of k!

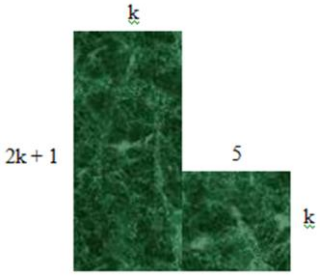


3. Pak Syarif has a swimming pool in his yard with a depth of 1 meter. If the width of the pool is 5 meter less than the pool length and volume is 50 m^3, please determine the width of the pool!

Figure 2. Questions item of mathematical problem solving I

Questions item of mathematical problem solving II

1. Pak Rudi will make a fence around the house. The height of the fence to be made is 4 m from Pak Rudi's house. The number of squares of the house and fence height is 40 m. Please determine the height of the fence!
2. The picture below shows the shape of a park with the area of 80 m². Please determine the value of k!



3. Andra has a first aid kit without lid with a length of 20 cm. If the width of the box is 2 cm less than the height and the volume is 2400 cm3. Please determine the height of the box!

Figure 3. Questions item of mathematical problem solving II

The data collected from this research consisted of the data from the students answer in solving mathematical problems supplemented with the data from the interview with the students. Data collection was carried out in two stages. At the first stage, the data was obtained from students answer on questions item of mathematical problem solving I which was followed by the result of interview based on students answer on the questions item of mathematical problem solving I. While the second stage was done a week after the first stage. At the second stage, the data was obtained from students answer on questions item of mathematical problem solving II which was followed by the result of interview based on students answer on the questions item of mathematical problem solving I. This process is carried out to see the accuracy of the data obtained in the first and second stages.

Data analysis in this research was conducted based on the stages of data analysis as stated by Miles and Huberman (1992), namely data reduction, data display, and conclusion drawing/verification. Data reduction was conducted by choosing, focusing attention, simplifying, abstracting, transforming raw data obtained from question items of mathematical problem solving and the interview result as well as carrying out validation to ensure the validity of the data obtained. Then, data display was conducted by preparing short descriptions in order to describe the mathematical problem solving ability of each student – i.e. climber, camper, and quitter, for each step of problem solving based IDEAL problem solving. The last stage was conclusion drawing to answer the research question concerning the mathematical problem solving ability of the climber, camper and quitter students based on the steps of IDEAL problem solving.

RESULTS AND DISCUSSION

Data obtained both from the students answers and interviews was then analyzed by referring to the stages of data analysis according to Miles and Huberman that has been mentioned above. The following are shown the results of the reduction, data display, and conclusion for each climber, camper, and quitter students at each steps of problem solving based on IDEAL problem solving.

Table 1.
The students' mathematical problem solving ability based on the steps of IDEAL problem solving viewed from their AQ

Steps of IDEAL Problem Solving	Aspects	Question	Students AQ					
			Climber		Camper		Quitter	
			I	II	I	II	I	II
Identify problem	Mentioning the data known from a problem	1	√	√	√	√	√	√
		2	√	√	√	√	-	-
		3	√	√	√	√	√	√
	Making link between known informations	1	√	√	√	√	-	-
		2	√	√	√	√	-	-
		3	√	√	-	-	-	-
Define goal	Mentioning information asked from the problem	1	√	√	√	√	√	√
		2	√	√	√	√	√	√
		3	√	√	√	√	√	√

	Explaining the adequacy of relevant information	1	√	√	√	√	-	-
		2	√	√	-	-	-	-
		3	√	√	√	√	-	-
Explore possible problem solving strategies	Finding various possible problem solving strategies	1	√	√	-	-	-	-
		2	√	√	-	-	-	-
		3	√	√	-	-	-	-
	Selecting the most appropriate strategy	1	√	√	-	-	-	-
		2	√	√	-	-	-	-
		3	√	√	-	-	-	-
Anticipate outcomes and act	Implementing the selected problem solving strategy with the use of correct formulas, algorithms and calculations	1	√	√	√	√	-	-
		2	√	√	√	√	-	-
		3	√	√	-	-	-	-
Look back and learn	Concluding the right solution	1	√	√	-	-	-	-
		2	√	√	√	-	√	-
		3	√	√	-	-	√	-
	Evaluating the steps of the work that have been done	1	√	√	-	-	-	-
		2	√	√	-	-	-	-
		3	√	√	-	-	-	-

Complements:
I : The questions item of mathematical problem solving I
II : The questions item of mathematical problem solving II
√ : The aspect is fulfilled
- : The aspect is fulfilled

Based on the table 1, for climber students, there are similarities in results between the questions item of mathematical problem solving I and II at all steps of IDEAL problem solving. Students could do all the aspects measured at each steps of IDEAL problem solving. Thus, it can be concluded that in solving the problems, the student identify problems, define goals, explore possible problem solving strategies, anticipate outcomes and act, then look back and learn.

Based on the table 1, for camper student, there are similarities in results between the questions item of mathematical problem solving I and II except for looking back and learning. In identifying the problem, the student mentioned data known from the problems and tended to make the link between known informations. In defining the goals, the student mentioned information asked from the problems and tended to explaine the adequacy of relevant informations. In exploring possible problem solving strategies, the student did not do all the aspects of the step. In anticipating outcomes and acting, the student tended to implement the selected problem solving strategy with the use of correct formulas, algorithms and calculations. In looking back and learning, the student only

concluded the right solution on one question for the questions item of mathematical problem solving I and he did not do all the aspects for the questions item of mathematical problem solving II. Thus, it can be concluded that in solving the problems, the camper students only identify the problems, define the goals, and anticipate outcomes and act.

Based on the table 1, for quitter students, there are similarities in results between the questions item of mathematical problem solving I and II except for looking back and learning. In identifying the problem, the student tended to mention the data known from the problem but he did not make the link between known informations. In defining the goals, the student mentioned information asked from the problems but he did not explain the adequacy of relevant informations. In exploring possible problem solving strategies, the student did not do all the aspects of the step. In anticipating outcomes and acting, the student also did not do all the aspects of the step. In looking back and learning, the student tended to conclude the right solution of the problems on the questions item of mathematical problem solving I but he did not do all the aspects on the questions item of mathematical problem solving II. The student also did not evaluate the steps of work that had been done on the questions item of mathematical problem solving I and II. Thus, it can be concluded that in solving problems, the quitter student does not do all the steps based on IDEAL problem solving.

Based on the analysis of data above, it was found that the mathematical problem solving abilities of the students based on the steps of IDEAL problem solving viewed from AQ were different. Despite several similarities, there are also some obvious differences between the climber student and the camper one. The climber student fulfilled all steps of problem solving based on the steps of IDEAL problem solving. Apart from his good ability in problem solving, he also showed strong willingness to complete all the problems given to her. For example, in question one of questions item of mathematical problem solving II, the student had been used to finding the root of quadratic equation by factoring. The student could also answer the question by using the quadratic formula. However, he faced difficulty when he was asked to do it by completing the square. Despite the difficulty, the student did not give up working on it although in the end he still did not find the answer. The following is the excerpt of interview between the researcher and the climber student including his answers.

PII124 : Ok, now try by completing the square.
RAClII124 : (Student trying to find the root of $2y^2 - 8y - 24 = 0$ by completing the square)
PII125 : How is it? You got it?
RAClII125 : Mmm, wait a moment Miss. (Student looked puzzled and faced difficulty in completing the work)
PII126 : You got it?
RAClII126 : (shaking his head, then looking at his work result again) As far as I remember, I should do it in this way, but I don't know the next steps. I usually used the factoring method, Miss.

The student answer using the method of completing square is written as below:

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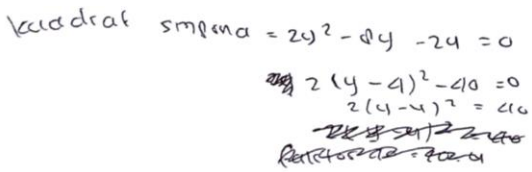

Figure 4. The answer of the climber student for question item 1 of questions item of mathematical problem solving II based on the interview above

Based on the excerpt of interview and figure above, it appears that the student only mastered two methods in finding the roots of the quadratic equation, except completing the squares. But the student still wanted to try to be able to recall and experiment using the method of completing squares in searching for roots of the quadratic equation requested. Another proof that shows student's good struggle is how student want to think and try the other strategy in the solving the problem that can be shown on table 16 above. Thus, the reasons made it reasonable if the climber student could go through all the steps of problem solving. It is in line with the explanation by Arslan and Yagzan (2015) that the climber student likes challenge and does not easily give up when facing difficulty.

The camper student did not explore adequately in solving problems. The student felt content easily with only one idea of solution that she thought was right. Based on the interview, the student also showed that he lacked enthusiasm and carefulness, both in exploring various problem solving strategies and in assessing his work, so that there were many mistakes found in his work. This is in line with the opinions of Arslan and Yagzan (2015) that the camper student prefers a safe zone. He/she also feels content easily when achieving something, so that he/she tends to reject to anticipate other better possibilities and tends to give up when facing difficulty in doing it.

The problem solving ability of the quitter student looked quite different from the other two types of students despite a few similarities identified between the camper student and quitter one. The problem solving ability of the quitter student looked still low in all steps of problem solving. Based on the interview, the difficulty of the student in doing all the steps of problem solving was caused by his lacking understanding of quadratic equation. However, the result of the test also indicated that the student was still unable to change a condition into a mathematical statement which is obviously related to linear equation. Thus, the low ability of the quitter student indicates that his achievement in learning mathematics on the learning materials related to questions items of mathematical problem solving is still low. Some answers of the student are shown below.

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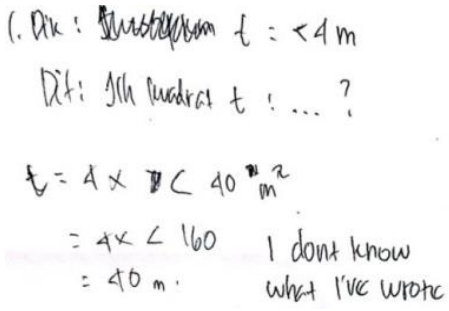

Figure 5a. The answer of the quitter student for question item 1 of questions item of mathematical problem solving I

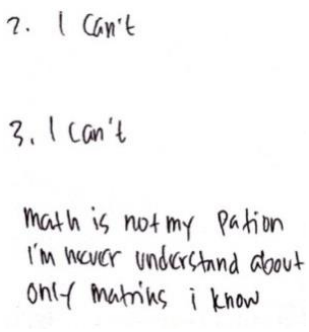

Figure 5b. The answer of the quitter student for question 2 and 3 of questions item of mathematical problem solving I

The other condition found is he student also seemed to give up easily in solving the problems. He was only able to concentrate on solving the problems for several minutes, and then he was just silent and watched his classmates doing the test. Based on the interview, he said that he is not interest and unmotivated in learning mathematics. It was observable when he was asked to solve the mathematical problems. Consequently, it was found that his answers ara very bad for all the problems. This finding agrees with the explanation by Arslan and Yagzan (2015) that the quitter student dislikes challenge and not interested in trying something new in his life. Some answers of the quitter student are shown in the figure below. It is also in line with the statement of Bennu (2012) at page 5 above.

The lack of effort that the quitter and camper students make does not mean that it can be overcome, since basically one's AQ can be learned, trained and developed (Stoltz, 1997). Thus, to help the quitter and camper students make their effort, assistance from various parties are required. This is because the student's surroundings play an important role to the success and achievement of learning (Kairienė, 2017). Teachers as part of the surroundings are expected to be aware of the abilities of their students. Teachers who recognize students' AQ are able to give motivation and attention according to the AQ levels of individual students. This is supported by the result of research by Devakumar (2012) that there is a significant correlation between AQ score and student's motivation. Thus, giving continuous motivation to students in the learning process, especially to the quitter students, can develop students' AQ more strongly than before. Teachers can motivate students to have positive thinking and courage to face a problem, since there is no problem that cannot be overcome as long as there is self-confidence and strong motivation to continue making efforts in facing any difficulty. This is in line with the result of research by Deesom (2011) that students who were trained to have positive thinking had higher AQ than those who were not. The AQ referred to in this research is limited to students' AQ in learning mathematics.

Based on the explanations above, it can be seen that the differences of the types of students' AQ affect the student's ability in solving problems. The higher the students' AQ, the harder their effort in solving problems and the better the result gained, and vice versa.

It is in line with the opinion of Deesom (2011) that having high problem solving ability reflects that the person has high AQ. The different problem solving abilities of the three types of student stem from the differences of their learning achievement of mathematics. This is in line with the finding of research by Oliveros (2014) that there is a significant correlation between AQ level and students' ability in solving problems. The low ability students in solving the problems certainly influences to students overall mathematical abilies and leads to the low achievement of students in mathematics. This is corresponding to the result of research by Suryadi and Santoso (2017) that the higher the student's AQ, the better his/her achievement. It is also in line with statement by Stoltz (2000) that a person successful in learning is one who has high AQ. Therefore, it can be said that AQ is very influential towards the outcome of learning, particularly students' mathematical problem solving ability.

CONCLUSIONS

In the scope of the research, the students' mathematical problem solving ability based on the steps of IDEAL problem solving viewed from adversity quotient (AQ) has been examined. As a result of the study, it is concluded that the problem solving abilities of the climber, camper and quitter students differ, namely: (1) the climber student solves problems by identifying the problem, defining the goal, exploring various problem solving strategies, anticipating outcomes and acting, and looking back and learning; (2) the camper student solves problems by identifying the problem, defining the goal, anticipating outcomes and acting, and looking back and learning; (2) the quitter student does do any of the five steps in solving problems. Further research can study in greater detail the factors which affect students' problem solving ability as well as investigate efforts to be applied to develop students' ability in solving problems, especially the quitter student.

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