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STUDENTS' HIGHER-ORDER THINKING SKILLS IN SOLVING GEOMETRY PROBLEM BASED ON ADVERSITY QUOTIENT

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Abstract

The goal of this research is describing students' higher-order thinking skills (HOTS) in solving geometry problem based on Adversity Quotient (AQ). Anderson and Krathwohl (2001) stated about HOTS that were consisted of analyzing (differentiating, organizing, and attributing), evaluating (checking and critiquing), and creating (generating, planning, and producing). According to Stoltz (2004), AQ category consisted of climber, camper, and quitter.

Purposive sampling was applied to the sample of this study i.e. the class of VIII-2 of SMPN 1 Srono, Banyuwangi, which consisted of 38 students (15 boys and 23 girls). This research was conducted in the second semester 2017/2018. Adversity Respond Profile (ARP) and geometry test were given to the students. ARP questionnaire, that had been developed, was used to determine the category of Adversity Quotient. Based on the analysis of 38 students, there were 3 climbers, 32 campers, and 3 quitters. The geometry test was used to determine the HOTS' level. Based on the analysis of 38 students, 17 students were correct in analyzing problem, 3 students were correct in evaluating problem, 2 students were correct in creating problem. Then, three volunteers that represent each category were chosen.

This research showed that students' higher-order thinking skills in solving geometry problem based on Adversity Quotient were different. Student with a higher AQ has higher skill level. Subject climber was able to show analyzing, evaluating, and creating skills. Subject camper was able to show analyzing and evaluating skill. Subject quitter had a small motivation to solve the problem although she might be able to solve it.

Keywords: higher-order thinking skills, adversity quotient, geometry

INTRODUCTION

In 2013, the government of Indonesia released a new curriculum. This curriculum evaluates three aspects, namely knowledge, attitude, and skill aspects. Attitude aspect evaluates behavior and character of the students, while skill aspect evaluates physical activity. This new curriculum indicates that knowledge aspect or cognitive aspect is not the most important goal in the learning process.

In Indonesia, most of conventional teachers usually evaluate the students based on their cognitive aspect, i.e. students' brain activity oriented on thinking ability. In contrast, Wade and Tavris (2007) stated that high Intelligence Quotient (IQ) and adequate practical knowledge did not guarantee the success. Those do not automatically bring people to the top.

Leslie (2000) emphasized that the success and non-success people had no significant different in IQ. She compared 100 most successful and 100 least successful men in the group. The successes included professors, scientists, doctors, and lawyers. The non-successes included electronics technicians, polices, carpenters, and pool cleaners, also a smattering of failed lawyers, doctors, and academics. The main differences that affected the success were confidence, persistence and early parental encouragement. Those turn out to be motivation. This research such as reverse something that is considered to be true by the people.

In global competition, schools shall be able to prepare the students to face the real world which full of problems and students must have struggle ability. What students need to face the real world and solve the problems is a high Adversity Quotient (AQ). Shek and Lin (2015) defined, "AQ is closely related to resilience. Resilience is defined as a dynamic process encompassing positive adaptation within the context of significant adversity or a characteristic of an individual who can respond quickly and constructively to crises". In education context, the role of Adversity Quotient is helping students to not give up, more endurable to misfortune, and not easy to desperate to face educational problems. So that, the importance of AQ is helping people with low and average IQ to increase their confidence since IQ does not determine the success.

Nowadays, knowing the students' achievement in a country is important since around 72 countries over the world join many tests, for example Program for International Student Assessment (PISA). This test diagnostically gives improvement to education system. Fifteen years old students, i.e. junior high school students, had involved in the test in literacy, science, and mathematics.

Many problems in PISA measure higher-order thinking skills of the students. Miri (2007) said that the development of higher-order thinking skills was important for the students to improve their ability to solve problems in a real life. Zohar and Dori (2003) stated that fostering students' higher-order thinking skills was considered to be important educational goal. Goldman (2002) denoted that improved thinking levels and types of skill provided a broader psychological resource for better thinking across a range of contexts. Since higher-order thinking skill is considered to be important, it must be managed.

Carden (2015) underlined that problem solving was significant to students' ability to translate formal education experience into skills for solving problem in a real life. People with formal education experience do not guarantee that they can solve problem in the real life. So, the use of problem solving is to improve the skill of the students in solving problem in daily life. Higher-order thinking problem relates to problem solving, as an important thing that must be developed especially by mathematics learning.

Geometry problems may perform interesting topics. In geometry, students already know about the formula but they cannot solve the problem if they do not understand the representation of two dimensional to three dimensional objects since spatial ability of each student is different.

In addition, Soenarjadi (2012) emphasized that in general, people knew object around them from its shape before they knew further about the object such as size, area, capacity, and etc. From the shape, people will have many questions about that object. Those questions will become problems if the path does not know before. So geometry is very important since it related to the real life. Therefore, the objective of this study is describing student's higher-order thinking skills in solving geometry problem based on Adversity Quotient, which consists of climber, camper, and quitter category.

RESEARCH METHOD

This descriptive-qualitative research was conducted in the class of VIII-2 at second semester 2017/2018. Purposive sampling was applied to the sample of this study. The class selection was conducted based on several criteria. First, the class had the same treatments. It means that the students were together since 7th grade. The students had the same mathematics teacher, material and the learning model. Second, that class is the best class in its grade, since higher-order thinking problems are non-routine problems, so it is suitable for both conditions.

The technique of data collection as follows:

1. Test Method

   The tests were ARP and geometry problem. ARP test was used to classify the students into three categories that consist of 30 questions, and geometry test was used to collect data about students' higher-order thinking skills in solving the problems that consisted of 3 questions about analyzing, evaluating, and creating problems. The test method was used to know the cognitive process of the student that cannot be seen since it happened in the brain.
2. Interview

   The interview was used to verify the result and understood the implicit information of geometry test result.

RESULT AND DISCUSSION

In the first test, the ARP test was given to the class of VIII-2 of SMPN 1 Srono, Banyuwangi, which consisted of 38 students (15 boys and 23 girls) to classify AQ category, i.e. climber, camper, and quitter. In the second test, the geometry test was implemented to the students to know the students' higher-order thinking skills.

The data consist of written test of geometry problems and interview transcript which is used to confirm the subjects' answer. The interview data is grouped by using label that consists of capital letters and numbers. The description of the label usage as follows:

1. First letters are labels for subjects based on AQ category, i.e. climber subject (CL), camper subject (CM), and quitter subject (QT).
2. The two following digits are labels for conversation order.
3. The last letter is label for the type of sentence, i.e. "Q" for question and "A" for answer.

Coding system is utilized to make it easier in indentifying the relation between interview data with the higher-order thinking skills. The indicator and coding system of higher-order thinking is presented as follows:

Table 4.1 The Indicators of Problem Solving

Skill	Indicator	Code
Differentiating	Students are able to understand the relevant information and cross out the irrelevant information from the problem.	A-D
Organizing	Students are able to identify the systematic and coherent relationships among the relevant information.	A-O
Attributing	Students are able to	A-A

Skill	Indicator	Code
	understand the point of view or intention of the author.	
Checking	Students are able to check the consistencies and inconsistencies.	E-H
Critiquing	Students are able to make judgments of a product or operation based criteria or standard.	E-R
Generating	Students are able to form the idea of the problem.	C-G
Planning	Students are able to devise solution method.	C-L
Producing	Students are able to create design that satisfies the criteria.	C-R

Based on the result of the ARP test, there are 3 climbers, 32 campers, and 3 quitters. According to geometry test result, 17 students were correct in analyzing problem, 3 students were correct in evaluating problem, 2 students were correct in creating problem.

The chosen volunteers are presented in the table as follows:

Table 4.2 The Chosen Volunteers

No.	Initial	Category	ARP score	Code
1.	EDS	Climber	171	CL
2.	CPAD	Camper	106	CM
3.	YI	Quitter	73	QT

Description and Data Presentation of Subject CL

In solving the problem, climber was able to solve all the problems. She had solved analyzing, evaluating, and creating problem. This is in line with the statement coming from Stoltz (2004), he said that climber wants to reach the top of success and ready to face the obstacles.

a. Analyzing

The answer of CL in solving analyzing problem is presented as follows:

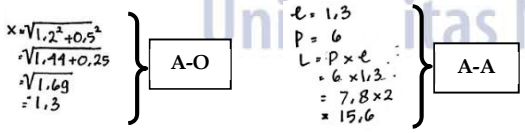

Figure 4.1 The Answer of CL in Solving Analyzing Problem

In the written answer, subject CL did not write the relevant information. Interview transcript of CL in analyzing the problem is presented as follows:

Label	Transcript	Code
CL01Q	*Apakah inti dari pertanyaan tersebut?*	
CL01A	*Mencari luas genteng rumah.*	C-A
Label	**Transcript**	**Code**
CL02Q	*Informasi apa saja yang diketahui?*	
CL02A	*Alas bangunan 2,2 , tinggi dinding 3, tinggi genteng 0,5, panjang genteng 1,2.*	A-D
CL03Q	*Panjang genteng atau jarak tepi genteng ke garis puncak genteng?*	
CL03A	*Iya, maksud saya itu.*	
CL04Q	*Lalu, apa lagi?*	
CL04A	*Lebar dinding ke tepi genteng 0,2, lebar dinding 6.*	A-D
CL05Q	*Menurut kamu manakah dari informasi-informasi tersebut yang tergolong dalam informasi yang penting?*	
CL05A	*Sisi panjang 6, tinggi genteng 0,5, dan tepi genteng ke garis puncak genteng 1,2.*	A-D
CL06Q	*Dari ketiga informasi penting tadi, apakah ketiganya memiliki hubungan?*	
CL06A	*Ada. Teorema Phytagoras.*	A-O
CL07Q	*Kenapa kamu menggunakan Teorema Phytagoras?*	
CL07A	*Untuk mencari lebar atap (menunjuk sisi miring genteng).*	A-O
CL08Q	*Dalam matematika, apa bentuk dari genteng tersebut?*	
CL08A	*Persegi panjang.*	A-A

The cognitive processes of student's analyzing skill in solving geometry problem are presented as follows:

1) Differentiating (A-D)

CL was told about relevant and irrelevant information in the interview. Relevant information is information in the problem which is used to solve the problem, while irrelevant information is information in the problem which is not used to solve the problem.

In identifying the given information, CL had still difficulties even though she knew about the part and the length. For examples, CL mentioned the height of the wall with the height of the building and the distance of the roof side to the vertical line of the roof top with the length of the roof. CL knew the part and the size, but she could not give a name on it. Hence, she was helped to entitle the given information.

2) Organizing (A-O)

CL's first step is finding the width of the roof by using the Pythagorean Theorem. CL said that there was relation between the relevant information of the problem. The relation was Pythagorean Theorem.

The relevant information of the height of the roof and the distance between the roof sides to the vertical line of the roof top were used to find the hypotenuse side of the right triangle. The hypotenuse side was the real width of the roof.

3) Attributing (A-A)

CL wrote the formula of rectangle to solve the problem. The length of the roof and the hypotenuse in the picture which was the width of the roof were multiplied to solve the problem.

CL said that the shape of the roof was two rectangles although the shape of the rectangles looked like parallelograms in the figure. Hence, CL used the formula of rectangle area, it was multiplied by two.

b. Evaluating

The answer of CL in solving evaluating problem is presented as follows:

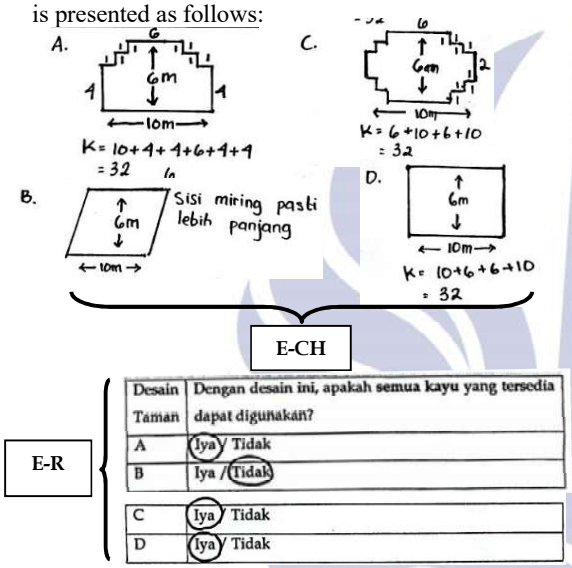

Figure 4.2 The Answer of CL in Solving Evaluating Problem

Interview transcript of subject CL in evaluating the problem is presented as follows:

Label	Transcript	Code
CL11Q	*Dari semua desain tersebut, desain manakah yang memenuhi kriteria?*	
CL11A	*Yang memenuhi yaitu desain A, C, dan D.*	E-R
CL12Q	*Bagaimana cara kamu mengecek apakah desain A memiliki keliling 32 meter?*	
CL12A	*Dengan cara menambahkan sisi-sisinya.*	E-H
CL13Q	*Bagaimana cara kamu mendapat angka-angka tersebut?*	
CL13A	*Diperkirakan secara logika.*	E-H
CL14Q	*Lalu, mengapa kamu menyimpulkan bahwa keliling desain B tidak sama dengan 32?*	
CL14A	*Karena tinggi desainnya 6, sehingga sisi miringnya pasti lebih dari 6. Saya jumlahkan panjang alas, sisi yang sejajar dengan alas, dan dua sisi miring, dan hasilnya lebih dari 32 meter.*	E-H
CL15Q	*Bagaimana cara kamu mengecek apakah desain C memiliki keliling 32 meter?*	
CL15A	*Sama seperti desain A, di perkirakan secara logika.*	E-H
CL16Q	*Bagaimana cara kamu mengecek apakah desain D memiliki keliling 32?*	
CL16A	*Karena desainnya berbentuk persegi panjang, jadi saya gunakan rumus keliling persegi panjang, yaitu panjang ditambah lebar lalu dikali dua.*	E-H
Label	**Transcript**	**Code**

The cognitive processes of student's evaluating skill in solving geometry problem are presented as follows:

1) Checking (E-H)

CL used the formula of circumference for evaluating whether the woods could cover 32 meter in length of the garden,. The circumference was the addition of all sides in the figure. CL checked each design by using trial and error.

In design A, CL substituted arbitrary number for checking the design. The result, CL found that the design was 32 meter in circumference. In design B, since the height of the parallelogram was 6, the hypotenuse is more than 6 for sure. So the circumference was more than 32 meter. In design C, CL substituted arbitrary number for testing the design. The result, CL found that the design was 32 meter in circumference. In design D, CL said that it was obviously rectangle. So CL used the formula of rectangle's circumference.

2) Critiquing (E-R)

CL was able to judge whether the designs had 32 meter in circumference after the checking process. The standard of the true statement in the problems was the total woods that could cover 32 meter in length of the garden's sides. So the criterion of the true statement was a design with 32 meter in circumference.

c. Creating

The answer of CL in solving creating problem is presented as follows:

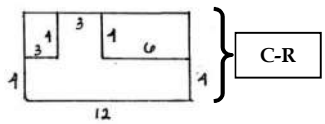

Figure 4.3 The Answer of CL in Solving Analyzing Problem

Interview transcript of subject CL in creating problem is presented as follows:

Label	Transcript	Code

CL17Q	*Apa saja yang diketahui dalam soal tersebut?*	
CL17A	*Panjang lahan 12 meter, lebarnya 8 meter, keliling 40 meter.*	A-D
CL18Q	*Apa syarat desain agar sesuai dengan permasalahan?*	
CL18A	*Semua sisi yang termasuk pagar jumlahnya 40 meter.*	C-G
CL19Q	*Lalu apa lagi? (Siswa berpikir). Sekarang kita lihat di soal nomor 2 tadi. Menurutmu, soal nomor 2 dan 3 ini serupa apa tidak?*	
CL19A	*Serupa.*	C-G
CL20Q	*Kamu tadi mengatakan bahwa nomor 2b tidak memenuhi kriteria, jelaskan lagi alasannya.*	
CL20A	*Karena tingginya kan 6 m, jadi panjang sisi yang miring tersebut pasti lebih dari 6 m.*	E-R
CL21Q	*Bisakah hal tersebut dijadikan syarat dalam membuat desain nomor 3?*	
CL21A	*Bisa. Tidak boleh ada sisi yang miring.*	C-G
CL22Q	*Apakah syarat tersebut sama dengan "sisi yang berdekatan harus tegak lurus?"*	
CL22A	*Sama.*	C-G
CL23Q	*Apakah ada syarat yang lain lagi?*	
CL23A	*Sisinya harus berhadapan dua kali.*	C-G
CL24Q	*Bagaimana rencana yang kamu gunakan untuk membuat desainnya?*	
CL24A	*Sesuai kriteria. Sisinya harus berhadapan dua kali, tidak boleh ada sisi yang miring, panjang dan lebar maksimum 12 dan 8 meter.*	C-L
CL25Q	*Jelaskan, apakah desain yang kamu buat sudah sesuai kriteria?*	
CL25A	*Sudah. Kelilingnya 40, sejajar dua kali, dan tidak boleh ada sisi yang miring.*	C-R

The cognitive processes of student's creating skill in solving geometry problem are presented as follows:

1) Generating (C-G)

CL was asked about the idea of the design in the problem and the requirements to make the circumference in 40 meter. CL said that the idea was making a new design in 12 x 8 meters area and the circumference of the garden was 40 meter.

CL recognized that this problem similar to the previous problem, so the design must be parallel for twice. It meant that when the sides were dragged, it could be form a side of rectangle. Moreover, the side must be perpendicular each other. According to CL's explanation in the evaluating problem, if the height of the figure was 6, then the skewed line was more than 6.

2) Planning (C-L)

CL made the design that was suitable to the criteria. From the design, the first thing that CL did was making a rectangle. When CL was interviewed, she said that the design could be any shape as long as the sides parallel for twice, the angle was 90°, and the maximum length and width were 12 and 8 meter.

3) Producing (C-R)

CL said that the design had maximum length and width 12 and 8 meter, the sides were perpendicular each other and parallel for twice. The length side was 12 meters, and the other was the addition among 3, 3, and 6 meters which was equal to 12 meters. The width side was the addition between 4 and 4 meters which was equal to 8 meters. The sides were not skewing, and parallel for twice.

Description and Data Presentation of Subject CM

In solving the problem, camper was able to solve most of the problems. She had solved analyzing and evaluating problem. This is in line with the statement coming from Stoltz (2004), he said that camper wants to face the obstacles but do not reach the top of success, and satisfied easily with what they achieve now.

In identifying the given information, CM faced difficulties while she knew about the part and the length. For examples, CM mentioned the height of the wall with the height of the building and the distance between the roof side to the vertical line of the roof top with the length of the roof. CM knew the part and the size, but she could not give a name on it. Hence, CM was helped to entitle the given information. Moreover, CM did not mention the given information simultaneously. Therefore, CM was asked for several times whether there was any information left.

CM's first step is finding the width of the roof by using the Pythagorean Theorem. CM said that there was relation between the relevant information of the problem. The relation was about Pythagorean Theorem.

The relevant information, i.e. the height of the roof and the distance between the roof side and the vertical line of the roof top, were used to find the hypotenuse side of the right triangle. The hypotenuse side was the real width of the roof.

CM wrote the formula of rectangle to solve the problem. The length of the roof and the hypotenuse in the picture which was the width of the roof were multiplied to solve the problem.

CM said that the shape of the roof was two rectangles although in the figure "front view", the shape of the rectangles looked like parallelograms. Hence, CM used the formula of rectangle area, and it was multiplied by two.

CM used the formula of circumference for evaluating whether the woods could cover 32 meter in length of the garden. The circumference was the addition of all sides in the figure. CM checked each design by using logical thinking.

In design A, CM substituted arbitrary number for checking the design. The result, CM found that the design was 32 meter in circumference. In design B, since the height of the parallelogram was 6, the hypotenuse was more than 6 for sure. So the circumference was more than 32 meter. In design C, CM substituted arbitrary number for testing the design. The result, CM found that the design was 32 meter in circumference. In design D, CM said that it was regular shape, i.e. rectangle. So CM used the formula of rectangle's circumference.

CM was able to judge whether the designs had 32 meter in circumference after the checking process. The standard of the true statement in the problems was the total woods that could cover 32 meter in length of the garden's sides. So the criterion of the true statement was a design with 32 meter in circumference.

Description and Data Presentation of Subject QT

In solving the problem, quitter was not able to solve the entire problems. She had not solved analyzing, evaluating, and also creating problems. She did not even try to write something in the paper.

This is in line with the statement coming from Stoltz (2004) that quitter choose to avoid and refused the challenge, easy to give up, tend to passive, and had no desire to reach the top. In other word, quitter does not take a chance nor give a try to solve the problems while she has a capability to solve the problem.

QT had learned about the material in the 7th grade. She also showed that she was still remembered about the formula of rectangle circumference and area and Pythagorean Theorem.

CONCLUSION AND SUGGESTION

Conclusion

In line with the result and discussion that had been explained, the conclusions that can be made are:

1. Climber's Higher-Order Thinking Skills
   Climber is able to:
   a. Identify the important information, but she faces difficulties in entitling the relevant information. She is also point out the relevant information, but at some points, she is unable to represent it in a language form.
   b. Identify the relation between the relevant information to solve the problem.
   c. Understand the point of view which is extended beyond the visible image in the problem.
   d. Test the designs based on criteria of the true statement, while the checking is combination between trial and error as planning and substituting arbitrary numbers as implementing.
   e. Critique the designs by determining the standard of the true statement based on criterion.
   f. Represent the problem by generating several ideas to make a new design.
   g. Devise solution in order to create a new design by using several criteria and substituting arbitrary number.
   h. Make a new design based on the criteria in the problem.
2. Camper's Higher-Order Thinking Skills
   Camper is able to:
   a. Distinguish the important information to solve the problem from the given information, but she faces difficulties in entitling the relevant information. She is able point out the relevant information, but at some points, she is unable to represent it in a language form. Moreover, she does not mention the given information simultaneously.
   b. Identify the relation between the relevant information. But in the interviewing process, she does not understand what the meaning of relation between the relevant information is.
   c. Understand the point of view which is extended beyond the visible image in the problem.
   d. Test the designs based on criteria of the true statement, while the checking is combination between logical thinking as planning and substituting arbitrary numbers as implementing.
   e. Critique the designs by determining the standard of the true statement based on criterion.
3. Quitter's Higher-Order Thinking Skills
   a. In the case of solving the problem, quitter is not able solve all of the problems.
   b. Quitter does not have a motivation to solve the problem, although she knows the basic concept of the material

Suggestion

There are several suggestions according to this research.

1. The future researchers are encouraged to conduct further research on different topic and grade.
2. This research shows that students' higher order thinking skills in solving geometry problem based on Adversity Quotient have difference in differentiating, evaluating, and creating skills. Hence, the teacher is suggested to pay attention to the students' Adversity Quotient level to increase their higher order thinking skills level. Moreover, this research as a foresight in developing learning strategy, the teacher may give more motivations to deliver the material and exercises in higher order thinking level as early parental

encouragement and persistence exercise to solve the problem.

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