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JUNIOR HIGH SCHOOL STUDENTS' ABILITY TO APPLY ALGEBRA IN REAL-WORLD PROBLEMS

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Abstract
In accordance with the 2013 curriculum that uses Scientific Approach where students learn using the 7M method (Observing, Questioning, Trying, Gathering Information, Reasoning, Concluding, and Communicating), the real problem is a tool which is considered fairly important to be used in learning. Mathematical modeling is an approach in which students bring real problems into mathematical problems. Algebra is an important tool used in modeling a real problem into a mathematical problem. Students are asked to observe the environment around them and then asked to make their mathematical model in an algebraic form. The subjects in this study were 21 eighth-grade students of Pangudi Luhur Junior High School in Srumbung, Magelang, Central Java, Indonesia. This research uses Qualitative Approach. The result of this study found that most students are able to create algebraic forms from the environment they have observed, but there are still difficulties. Some groups still need quite a lot of help from teachers but some also need a little help from teachers.

Keywords: algebra, mathematical modeling, environment

Introduction
Math learning still poses a constant problem. The frequently recurring problem is how to put mathematics in the students' perspectives. It is expected that when the teaching of mathematics is applied in daily lives, the meaningfulness of learning mathematics among the students can be fostered. As other branches of science, mathematics requires a laboratory for the process of meaning-making. However, the idea to build a mathematical laboratory is pictured is a sophisticated equipment, which not all schools can afford to do it. For that purpose, we need a creativity to initiate a mathematical laboratory that does not require high cost. One of the answers to the problem is to use the natural surroundings and environment as a natural laboratory to serve as a means for the students to learn and process.

The implementation of Curriculum 2013 invites all parties to be more enthusiastic and optimistic about achieving a better education. Curriculum 2013 puts more emphasis on modern pedagogic dimension using scientific approach in the process of learning. A scientific approach is believed to be one of the best

bridges to enhance the development and development of attitudes. In addition, the learners' skills and knowledge in work processes that meet these scientific criteria will be fostered. In the concept of scientific approach presented by the Ministry of Education and Culture, there are at least seven criteria.

1. Learning materials based on facts or phenomena that can be explained by certain logic or reasoning; Not merely imagination, fantasy, legend, or myths.
2. Teacher's explanations, student responses, and teacher-student educational interactions are free from the immediate prejudice, subjective thinking, or reasoning that diverges from the logical thinking flow.
3. Encourage and inspire students to think critically, analytically and precisely in identifying, understanding, solving problems, and applying learning materials.
4. Encourage and inspire students to think hypothetically in viewing differences, similarities, and links between one learning material to another.
5. Encourage and inspire students to understand, apply, and develop rational and objective thinking patterns in responding to learning materials.
6. Based on concepts, theories, and empirical facts that can be accounted for.
7. The purpose of learning is formulated in a simple and clear, but interesting system of presentation.

The learning process using the scientific approach is a blend of learning process that was originally focused on exploration, elaboration, and confirmation equipped with observing, asking, reasoning, trying, and communicating (Kemendikbud, 2013). Some people develop these processes into to observe, question, collect data, process data, communicate, innovate and create. However, the purpose of some learning processes that must exist in the same scientific study is to emphasize that learning does not only occur in the classroom, but also in the school and community. In addition, the teacher simply acts as a facilitator when children / students / learners experience difficulties. Moreover, teachers are not the only source of learning. Attitude is not only taught verbally, but through examples and examples.

In the learning process students are expected to find meaning and understand what is actually learned. By taking the background of the real problems that can be captured by the senses coupled with the experience of each individual and collaborated in a group work, it is expected to provide more sufficient supplies for their life skills.

What are the different learning activities where students are invited to apply mathematic concepts in real life through the activities of teaching instructions in which teacher realizes math? When teachers use guided question techniques and try to teach mathematics to serve some useful purposes, they rarely try to sort out why other sensible ideas are less useful for a particular situation and purpose. They rarely make connections between networks of ideas taken from different topic areas. They rarely emphasize the modeling capabilities required when complex artifacts are produced using a design-test-revision cycle. However, this high level of understanding and modeling capabilities is needed for success

outside of school (Lesh, 2003). When a problem is used to create a symbolic description of a meaningful situation, the processes and capabilities required also tend to be almost inverse of the calculating skills that are emphasized in most story problems (Lesh, Cramer, Doerr, Post & Zawojewski, 2003 in Lesh, 2003)

The process of meaning-making in the use of real problem can be realized by, among others, using learning which encourages problem solving. The problem-based learning model can develop students' ability to understand the problem, the ability to plan the solution, the ability to execute the solution plan, and the ability to recheck (Siti Mawaddah & Yulianti, 2014). The process of incorporating real-world problems into math problems often invites problems of their own. The process of bringing real problems into existing symbols or in mathematical terms associated with algebraic material is a skill or ability that does not automatically developed among the students. This is what often makes teachers think that algebra learning seems to have many obstacles.

If this can be well developed, it is not impossible for students to be able to solve real problems with mathematics or so-called mathematical modeling is applied. Mathematical Modeling by Haines and Crouch (2007) posits that the characteristics of mathematical modeling is a process cycle of real-life problems translated into the language of mathematics, solved by using the rules in mathematics, and the solution is returned or tested to see whether to the real problem is appropriate or not. This research attempts to see the ability of junior high school students in interpreting the symbols in algebra based on real problems raised by the students themselves.

Method

This research uses a qualitative approach with a case study method. The data collected are in the form of words, images and not numbers. This is due to the application of qualitative method. The purpose of the case study is to provide a detailed picture of the background, character traits and characteristics of the case or status of the individual from which they will be made public. In this study, the researcher wanted to know the ability of the eighth grade students of SMP Pangudi Luhur Srumbung in bringing real-life problems in the surrounding environment into algebraic forms.

The subjects in this study were the eighth grade students of SMP Pangudi Luhur Srumbung, Magelang, Central Java. The eighth grade students were selected because the researchers were preparing the students to be able to create a scientific work in the field of mathematics.

The duration of the study at Pangudi Luhur Srumbung Junior High School was about 1.5 months. The research started to observe the class on August 3, 2016, when the researcher arranged the research schedule with the homeroom teacher of the eighth grade students who also happened to be the mathematics teacher at the school. It was agreed that the research time would be between August 4, 2016 and September 7, 2016 every Wednesday after school. The date was determined so that students could focus more on the scientific work they wanted to deepen. In addition, the research was conducted after school so as not to interfere with the teaching learning activities.

The research subjects were the eighth grade students of SMP Pangudi Luhur Srumbung. The target of this research was to encourage the students to bring real problems into the form of mathematics. Thus, it aims for the students to change everyday problems into algebraic forms. The stages in this study are described as follows:

1. Pre-research stage
   Asking for research permission from the Principal of SMP Pangudi Luhur Srumbung, Magelang Central Java; observing of students' processes and abilities, especially students' comprehension skills; observing the surrounding environment in Srumbung area to be a topic in making Scientific Works; conducting interviews with teachers of mathematics; and selecting classes as research subjects
2. Planning Stage
   Students are asked to form groups of five to six students and students are asked to see the environment around the school.
3. Stage of Action
   Students are asked to observe one of the objects in their surroundings; students are asked to draw objects they observe; students are asked to make inquiries from what they observe; students are asked to develop problems they make in groups; and students are required to solve the problems they make
4. Reflection Stage
   Collecting data and analyzing data.

In this study, the preliminary data were collected, i.e. observations of students of Pangudi Luhur Srumbung Junior High School. After that, the other data collected were those related to any problems they could find related to the object they chose. The last data to be obtained were the data where students chose one fairly good topic to be developed and resolved afterwards.

The instrument used in this research was the objects that exist in the environment of Pangudi Luhur Junior High School, because the objects that were mentioned by the students were found in the environment of Pangudi Luhur Junior High School. In addition, other instruments were the researcher in which he also guides and provides input to the students of SMP PL Srumbung.

The technique of data collection in this research was done in stages. First, the obtained data included the data of the selected objects. The next stage involved data on what issues could be raised and related to the topic chosen by the students. Then the last stage involved the data where students developed one of the problems with enough depth which then they solved in groups.

In this study, the technique to analyze the data used a qualitative analysis, namely to see the development of the process of students' teamwork to show their ability to bring real-life problems into algebraic forms in accordance with the problems they observed and raised. At first, they were asked to look and then look more closely at the objects they observed. After that, they were asked to observe any problems they could find. Then, they chose a problem that was quite

interesting and they were asked to develop the problem which they were then asked to solve.

The purpose is to see the process in which the eighth grade students of SMP PL bring the real problems into the forms of mathematics. This is very important because it is the basis for them to be able to make scientific work in the field of mathematics. In addition, the importance of viewing this process is to see the researcher's findings on the students' ability to bring real problems into algebraic forms, especially the obstacles found by the students in the process.

Findings and Discussion

This research began by dividing the students into groups containing five to six students each group. The obstacles that arose in the process of making the group were that the students felt uncomfortable with their group mates because they were not close personally or because they did not belong to the same "gang". Fortunately, this happened only at the first meeting because in the next process they were able to work in groups well.

After the formation of the group is completed, they were asked by researchers cum supervisors to go out of the class, where they were instructed to see objects located in the neighborhood around SMP Pangudi Luhur Srumbung. Then they specified the objects to be observed further. The selected object of the group was ceramic floor (Figure 1), water tap (Figure 2), and alkaline water containers (Figure 3).

Figure 1. Photograph of the ceramic tile observed by group one

Figure 2. Photograph of a water tap observed by group three

Figure 3. Photograph of the alkaline water containers observed by group two

After observing the objects selected by the groups, the students were also asked to draw the objects they specified in the group. The drawings of the objects of the students' work are shown respectively in the following figures: the ceramic tiles drawn by group one (Figure 4), the water tap drawn by group three (Figure 5), and the alkaline water container drawn by group two (Figure 6).

Figure 4. Ceramic tiles drawn by group one

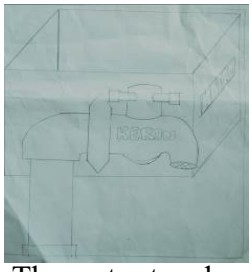

Figure 5. The water tap drawn by group three

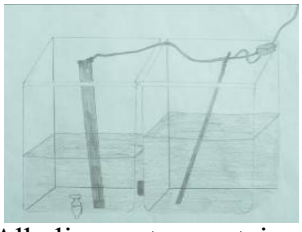

Figure 6. The Alkaline water container drawn by group two

In the following week, students were given the task by the supervisor to raise any issues in everyday life to into math-related issues. The results show that most of the problems they created were preceded with the word "how much", as shown in students' work (Figure 7 and Figure 8). This shows that the students' ability in making mathematical problems was still quite limited. In addition, it was found that the students only formulated problems that matched their abilities or in other words, they only created problems they could solve (Figure 7 and Figure 8).

1. How long does it take to drink the water in the container?, 2. Each container is filled with 10 liters of water. If the water in the alkaline water contained is reduced by 5 liters, how much is the volume of water in the acid water container?, 3. How much voltage is needed in a month?, 4. How much water discharge is needed to fill a 200-ml glass?, 5. What is the length and width of the container?, 6. What is the weight of iron in the container?, 6. How much water is reduced on a daily basis, if there are 64 students in Pangudi Luhur Junior High School?

Figure 7. Problems formulated by the group

1. How many meters of PVC drains are needed?, 2. How much water is flowing to the pail per minute?, 3. If there are 2 drops of water per 3 seconds, how many drops of water are there in an hour?, 4. How much water is flowing?, 5. Mr. Moko has 1 fish pond. To fill up the pond, it takes 2 hours. How fast is the water flow?, 6. If it takes 2 hours to fill 1 pond, what is the volume?, 7. Bu Tiara wants to wash clothes. How much water is needed to wash clothes?

Figure 8. Problems formulated by group three

This happened because the students were worried if they were told to solve their own problems and they could not do them. Another reason is that students were reluctant to formulate complicated math problems because it would take a lot of time if to finish them.

Looking at the results obtained, the researchers agreed that for the next week students were asked to do one of the problems they chose to develop for the better. Here, the researcher played an important role in giving input on the development of problems selected by the groups. This is done because basically the students were not yet accustomed to developing the problems in more depth.

Group one was actually told to improve the questions according to the researcher's advice but failed to do so, as shown in Figure 9. This happened due to their bad habit of not taking notes of any feedback from the supervisor and researcher. Group two had tried their best but still the result was far from being satisfactory (Figure 10).

Each jar contains 10 liters of water. If everyone drinks one glass of 200 ml, is it enough for all 65 students of SMP PL?
It is known: Each jar contains 10 liters, there are 2 jars: 10 x 2 = 20 liters; number of students: 65 students; 1 cup: 200 ml; every day students drink 1 glass
Resolution/Answer:
20 l – (65 x 200 ml) = 20 l - (65 x 0.2) l
= 20 l – 13 l
= 7 l
So, the remaining water supply for 65 students = 7 l
Conclusion: So, the water supply is enough for 65 students, and the remaining is 7 liters.

Figure 9. Problems formulated and solved by group one

The classroom of the third-grade in SMP PL was not yet installed with ceramic tiles. The Principal wanted to install 40x40cm tiles in that 7x8 meter room. How many ceramic tiles are needed?Answer to the problem:
Area of the Room: 7x8
: 56 $m^2 = 560{,}000\ cm^2$
Area of ceramic tiles : 40 cm x 40 cm
: 1,600 cm^2
: 560,000 : 1,600
: 350

Figure 10. Problems formulated and solved by group two

The results of the study initially showed that students were able to solve the problems they created but still in the common form and not into the algebraic form (Figure 10). They had learned algebraic materials in the seventh grade but no one had applied it yet. It so happened that the problem they raised was related to Function and they had not learned it yet. As a result, they finished the problems in any way they could (Figure 11). For problems which were not related to Function, they had already applied algebra in formulating problems based on the input from the researcher (see Figure 12 and Figure 13).

1 pond	Time needed:	21 hours, 18 minutes
2 ponds	Time needed:	42 hours, 36 minutes
3 ponds	Time needed:	63 hours, 54 minutes
n ponds	Time needed:	21 x n hours 18 x n minutes

Figure 11. Problem solving using algebraic math done by group three

The classroom of the third-grade in SMP PL was not yet installed with ceramic tiles. The Principal wanted to install 40x40cm tiles in that 7x8 meter room. How many ceramic tiles are needed?Answer to the problem: The room is rectangular in shape.

L.r = p x l — L.r. Area of the room
= 8 m x 7 m
= 56 m^2
= 560.000 cm^2

The size of the ceramic tile 40 cm x 40 cm

L.k = s x s — L.k. Size of the tile
= 40 x 40
= 1,600 cm^2

Finding out the number of ceramic tiles

L.r : L.k = 560,000 : 1,600
= 350 ceramic tiles

Figure 12. Problem solving using algebra done by group one

Grandpa Yatman has a fish pond. The water needed to fill the pond is as much as 5,000 liters. For 100 liters of water, it takes 5 minutes. Grandpa Yatman filled the pool at 6:00 am. What time is the pool full of water?
How to solve the problem:
5,000: 100 = 50
: 50 x 5 = 250 minutes
= 3 hours 10 minutes
: 06.00 + 03.10 = 09.10 a.m.

Figure 13. Problem solving using Algebra done by group four

From this stage, the researcher had to wait until the mathematics teacher taught the relation between real problems related to Function, so that the students could formulate real problems into algebraic formulae and in turn, they could return them to the real world (to mathematize the world). In addition, students would gain understanding of the materials on Function because they could incorporate Function into the real-world problems they observed in the environment (Figure 14)

x = 200 ml
65 x = f (x) = 200 ml x 65
13000 ml = 13 l
Remaining water = 20 l – 13 l = 7 l

So, the water supply for 65 people is 131 and the remaining water is 7 liters.
It means that:
1 day = 13 l
2 days = 26 l
3 days = 39 l
n days = 13 x n

a		y	y = f(a) = 20a – 7a
1	----------	13	f(1) = 20(1) – 7(1) = 13
2	----------	26	f(2) = 20(2) – 7(2) = 26
3	----------	39	f(3) = 20(3) – 7(3) = 39
4	----------	52	f(4) = 20(4) – 7(4) = 52
5	----------	65	f(5) = 20(5) – 7(5) = 65
6	----------	78	f(6) = 20(6) – 7(6) = 78
7	----------	81	f(7) = 20(7) – 7(7) = 81

Figure 14. Problem solving using algebraic math done by group two

Conclusions

From the results of this study, it is concluded that students were basically able to bring real problems and formulate them in mathematical problems. The result of this research is that students were able to observe the environment around SMP PL and formulate the observed phenomena into math problems. In addition, students were able to interpret algebra and used it well in real-life activities. However, since this is still quite new for the students, so this habituation has not been easy. Some students still had some difficulties in changing the issues in the real world into algebraic forms. So for this research, a supervisor plays a significant role in helping the students to construct real problems into algebraic formulae in order to solve them. Problems made by the group still use the word "how much" and the complexity of the problem was still inasmuch as to be solved by the group itself.

The suggestion of this research is the need to be developed again in terms of observing the surrounding environment. Besides, the problem formulation can also be developed. If in this study, the group formulates the problem then solves it

themselves, then for further research, they can be asked to formulate problem questions made by groups who are observing but problem solving can be done by other groups. The last thing to be suggested is that the problem can be developed but students are prohibited to use the word "how" to further hone and enrich the students in matters related to mathematics that is taken from the natural environment.

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