Imitative and creative reasoning for mathematical problem solving (in context horticultural agribusiness)

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Abstract. The aim of the research is to describe the ability of imitative and creative reasoning for mathematical problem solving, in context of horticultural agribusiness. The research was held by qualitative approach toward six students as of participants, all of them are vocational students of horticultural and agribusiness in Tasikmalaya, Indonesia. The students were given a test and interviewed in order to get the Data about the ability of mathematical reasoning. Here are the result: (1) No student do memorize reasoning; (2) students' reasoning when the logarithmic remember mathematical procedures; (3) The students started the process of solving the problem by using the procedures of cultivation, then follow up with a mathematical procedure, in this case, the students do local creative reasoning; (4) students do creative reasoning to create a sequence of procedures, suggests a predictive statement based on the nature of mathematics; (5) students helped solve the problem s presented in the context of agro business-horticultural competence. These results show that the mathematical problems presented in the context of agribusiness-horticultural reasoning raise a lot more creative.

1. Introduction
Reasoning in this study was adopted from thinking [1], which we summarize in the definition, types, and criteria of reasoning. The reasoning is a line of thought to get the statements and conclusions during the troubleshooting process. There are two types of reasoning, imitative and creative reasoning. Imitative reasoning subdivided into memorized and algorithmic reasoning. Criteria of memorized reasoning are the strategy of choice is founded on recalling a complete answer and implementation consists only of writing it down. Criteria of algorithmic reasoning are the strategy of choice is to recall a solution algorithm and the remaining reasoning parts of the strategy implementation are trivial for the reasoner, only a careless mistake can prevent an answer from being reached. Criteria of creative reasoning are a novelty, a new (to the reasoner) reasoning sequence is created, or a forgotten one is re-created, plausibility, there is arguments supporting the strategy of choice and/or strategy implementation motivating why the conclusions are true or plausible. This reasoning also as a mathematical foundation. The arguments are anchored in mathematical intrinsic properties of the components Involved in the reasoning [1].
Reasoning has an important role in solving the problem, either a matter of routine and non-routine problems. Routine matters are problems that never or often encountered a student and have an algorithm that is ready for use. The problems of non-routine are the new problem encountered students so that new methods are needed to solve them [2]. The creative reasoning is a driving force to create a new method of solving the problem. In addition, creative reasoning can encourage students' mathematical competencies such as the ability of understanding and solve mathematically [3]. Failure in solving the problem can be determined by imitative reasoning [3]. That is because many students are fixated on an algorithm derived from the textbook or teacher who taught him.

Reasoning abilities of the students affected by the manner and process of thinking, which includes the student competence mastery of mathematical concepts, as well as the environment. The environment can affect student competence that can affect thought processes, and the environment can influence the thinking process. Thus, the largest most influential aspect of the reasoning is the environment. These three things can affect the reasoning sequence a student [1].

An environment that stimulates reasoning ability can be created in the learning process. Teachers can provide mathematical problems whose solutions are open and allow students to discover new methods of problem solving. A mathematical problem whose solution is procedural (algorithmic) does not encourage students to develop their competence [3]. In addition, students also have competencies outside mathematics that are obtained from lessons other than mathematics. Vocational high school students have certain vocational competencies that are prepared for the world of work. Vocational problems often require math as a tool for solving vocational problems. Mathematics in the workplace does not stand alone, therefore it takes the effort to make mathematics education more realistic in accordance with the needs of the working world [4]. For example, interdisciplinary research [5] combines mathematics with the field of nursing, namely solving the problem of drug dosage calculations.

Vocational high schools are one of the secondary schools that prepare their students for work. Vocational high schools in Indonesia have nine areas of expertise with a diverse range of competency skills. One of the skills competencies in vocational high schools is agribusiness of food crops and horticulture which includes areas of agribusiness and agrotechnology expertise. The scope of horticulture crop agribusiness competence is very wide, therefore, in this study, the horticultural agribusiness context is chosen as the limitation of the math problem tested to the students. Horticulture is the science and technique of production, processing, and sale of fruits, vegetables, flowers, spices, plantations, medicinal and aromatic plants [6]. Horticultural agribusiness is an agricultural activity that includes market-oriented horticultural commodities and the acquisition of added value. There are three phases of agricultural growth, namely inductive, stimulative and simulative [7]. The inductive phase is characterized by intensive crop production with the support of seeds, fertilizers, agrochemicals, and irrigation. The stimulative phase is characterized by the empowerment of farmers. The simulative phase is marked by the process of adding values. Sustainable horticultural systems are increasingly gaining attention in agriculture as demand for world food production is increasing [8]. Therefore, horticulture agribusiness is an important competency possessed by vocational students in the field of agribusiness and agrotechnology expertise.

The context for mathematical problems is presented by horticultural agribusiness context. First we look for mathematical concepts studied at the vocational high school level. The concepts must be connected to the context of horticultural agribusiness. After that we build math problems. Another consideration in the preparation of mathematical problems is, it should enable students to make imitative or creative reasoning. The purpose of this study are (1) to obtain a picture of the imitative and creative reasoning ability of vocational high school students who have competence in agri-food crops and horticulture in the troubleshooting process in the context of agribusiness and horticulture; (2) the effect of the mathematical problems in the context of agri-horticultural against imitative and creative reasoning.
2. Experimental method
The research method is descriptive, qualitative approach. The subject as many as six people who were students of 12th-grade Vocational High School Competency Agribusiness Food Crops and Horticulture in Tasikmalaya. They consist of two men (M-1 and M-2) and four women (W-1, W-2, W-3, and W-4). To reveal the imitative and creative reasoning skills in problem-solving, subjects were given a test with four mathematical problems in the context of agribusiness horticulture. Then, do interviews on the subject to dig up answers statements written in the answer sheet and determine the effect of agribusiness horticultural context of the reasoning of students during the troubleshooting process. Next, do a thorough analysis of the results of tests and interviews to determine the ability of the imitative and creative reasoning mathematically. The analysis was conducted based on the criteria of the imitative and creative reasoning advanced by [1]. Math problems in test questions presented in the context of agribusiness horticulture. Mathematical concepts are predicted to arise in the process of solving the problem is the concept of algebra, matrices, sequences, and geometry. Here are the problems of mathematics used in this study.

(PS-1) A farmer has a 3x4 meter plot of land. He plans to intercrop cultivation of pepper and tomato. (a) Make a sketch of the cropping pattern in the location of the land. (b) What is the distance between the planting tomato plants and peppers? (c) How many chili and tomato plant populations is needed.

(PS-2) A farmer has a target of selling their crops with a weekly average of more than or equal to Rp. 10,000,000,-. Sales for six consecutive days are presented in table 1. Determine the sale of at least seven days so that the target is reached.

| Day | 1     | 2     | 3     | 4     | 5     | 6     |
|-----|-------|-------|-------|-------|-------|-------|
| Sales (USD) | 9,500,000 | 11,000,000 | 9,000,000 | 8,000,000 | 12,000,000 | 12,500,000 |

(PS-3) Income harvest a crop at the end of 2011 is Rp.6,000,000,. Starting in 2012, the plant with fertilizer which is the result of research and development innovation agricultural hall. Based on these results, it is estimated that each end of the harvest will rise to Rp 300,000,-. What is the estimated harvest at the end of 2017?

(PS-4) A farmer plans to process the harvest of mangoes, bark, and kedongdong be candied. The main cost of making sweets and many sweets produced is calculated per semester are presented in table 2 and table 3.

|               | Plant       |               |               |
|---------------|-------------|---------------|---------------|
|               | Mango       | Salak         | Kedondong     |
| Fruit         | 3,000       | 1,000         | 1,500         |
| Sugar         | 2,000       | 2,500         | 3,000         |

| Product | Season |       |       |
|---------|--------|------|------|
| Mango   | Dry    | 4,000| 3,000|
| 4,500   | 3,200  |
| Kedondong| 3,000 | 2,800|

Make a table showing the total cost of processing candied each semester in each category of fruit and sugar.
3. Result and discussion

3.1. Mathematical problems in the context of agribusiness and horticulture

Many things must be considered in designing a mathematical problem. In this study, the design task considering the context of agribusiness and horticulture, imitative and creative reasoning, mathematical concepts they have learned in vocational high schools. The mathematical problem presented in this study can be resolved by procedures that have been given by teachers or textbooks. However, it can also be solved by a method developed by the students. Because of the problems presented in the context of agribusiness horticulture, then these problems become visible is not routine. It can affect the reasoning carried out by the students, the reasoning of students affected by the nature of the tasks that are designed/selected by the teacher. Moreover, these problems are designed to provide space for students to take advantage of vocational competence in this agribusiness horticulture [3].

Subjectively, mathematical problems that are presented in this study belong to the non-routine problem for several reasons. First, based on the interview, the student never received a math problem in the context of agribusiness as given in the study, except Problems PS-1, is a matter of routine in agribusiness. Secondly, there are several procedures to resolve these issues and encourage creative reasoning. Third, the problem presented in word problems so as to enable students to understand the sentences first before determining the proper procedures. The first reason has individual perspectives, it means the situation is seen as a problem by the individual. The second and third have a viewpoint based on the nature and purpose of the provision concerns in this regard to develop mathematical reasoning abilities. Yeo classify this type of problem from the viewpoint of the individual and the purpose of the issue [9].

Designing creative reasoning problems are not easily comparable algorithmic problems. Creative mathematical problem is a problem where there is no complete solution method and requires students to constructing sanely [3]. Designing a math problem in the field of vocational require hybrid capability [10], namely mathematical skills and vocational training.

3.2. Imitative and creative reasoning in problem solving in the context of agribusiness horticulture

Analysis of the reason students do each item problem. There are three basic findings of problems PS-1. First, assuming the student in making a sketch of the land is divided into two groups, namely, students considering the productivity of the land and did not consider it. Second, the calculation of the number of plant populations using a formula that is studied in the field of plant cultivation. Third, open-ended question that allows students to provide answers in accordance with the assumptions. There are imitative and creative reasoning in problem-solving PS-1. The creative reasoning appears in the determination of the initial assumptions about the placement of plants and plant spacing. W-1 and W-2 have assumptions as in Figure 1 (b), while the M-1, M-2, W-3, and W-4 has assumptions as in Figure 1 (c). When an interview to ask the assumptions chosen, the M-1 states that he learned the theoretical cultivation in agriculture. W-4 recounts when the following field practice activities in a plantation cultivation of tomatoes and peppers. M-2 fixated on mathematical concepts only, not the assumption of agricultural knowledge. The situation of M-1, W-4 and M-2 is explained at Figure 1 (c).
Figure 1. Sketch of placement of plants and plant spacing chili and tomato.
Mathematically, the answer to M-2 is the most correct. M-2 reasoning imitative, which uses mathematical procedures. However, it does not make sense when applied in plant cultivation system. The answer is pretty reasonable is the answer of the M-1, even though in theory intercropping cultivation, planting position as shown in Figure 1 (a) is rarely done. W-1, W-2, W-3 and W-4 improper reasoning. It is seen from a mismatch between the sketches made with the required number of population. Based on this description, students perform local creative reasoning [11], using the logarithmic reasoning but contain creative reasoning.

The PS-2 problem can be solved either by the M-2 and W-2. When the interviews, they do not know the mathematical formal procedure. They tried to solve the problem in his own way. M-2 performs the sequence of solving the problem.

- Total sales during the six days are Rp.62.000.000.
- The average weekly sales of Rp. 10,000,000 multiplied by seven days is Rp. Rp.70.000.000.
- Sales of the seventh day, in order to target average weekly achieved, is Rp.70.000.000-Rp.62.000.000 = Rp.8.000.000.

W-1 started thinking about total sales for seven days shall Rp.70.000.000, by reason of the average weekly sales Rp.10,000.000. Then, he predicts that the seventh-day sales total sales Rp.70.000.000. M-2 and W-1 create a sequence of predictive reasoning itself with the argument so that both of them belong to the creative reasoning. On the other hand, W-3 and W-4 to calculate the total sales for six days and dividing by six. They consider questions such problem is the average sales for six days. M-1 and W-2 confusion determine problem-solving strategies. He only calculates the total sale only.

Five students can solve problems PS-4 with nearly the same resolution procedure. They summing profit end of each year from 2012 to 2017, and then add it to the yields at the end of 2011. None of them can formulate with the procedure determines the tribe to-n of a row that they have acquired in the material sequence and series. When confirmed during the interview, they forget that procedure. When students do not know about the settlement procedure, there are two possibilities of the student is guessing or build arguments either explicitly or implicitly to make selection procedures and conclusions in order to obtain a solution [3]. On the other hand, the first P-2 to understand the problem as the sum of the number of years multiplied by the increase in yields. Then, after rereading the question, he just woke up and did a completion strategy with the sequences 6,63,66,69,72,75,78. He said the solution of the problem of PS-3 was 7,800,000.

Problems PS-4 procedurally is the concept of multiplication of two matrices. Only the M-2 that do two matrix multiplication procedure. However, when asked during the interview, the M-2 that he does not know is the product of two matrices. Other students do not understand the problem, the procedure used was not unreasonable. W-4 states that every expense is presented multiplied by two, because who asked costs in half. W-3 totaling the cost of each sugar and fruit, then multiplying the product produced each season. M-1 multiplies each component of fruit and season. W-1 combines two tables that include all the components listed in Table 1 and Table 2. W-2 summing the individual needs of fruit and sugar, and then multiply by the number of production each season.

Based on an analysis of each item problem, a student doing a different reasoning to solve problems of each egg. No student do memorize reasoning, because of the kind of problem in the form of word problems that had met not possible based on the answers given, unless the problem PS-1. Selection problem-solving strategies with the strategy that has been studied in the field of plant cultivation including the logarithmic reasoning. The standout creative reasoning is M-2. He created the order of reasoning, argued that support reasoning predictive statement and the statement is based on the nature of mathematics for some problems, the M-2 local creative reasoning, and partly global creative reasoning. There are two types of creative reasoning, namely local and global creative reasoning [11].
3.3. Influence of Mathematical Problems in the Context of Agribusiness Horticulture against the reasoning

Basic question when the interviews are "Is math problems presented in the context of agri-horticulture helps the process of solving the problem?". All students answered "Yes". Students are helped to solve the problem in the context of an agribusiness horticultural competence. Sentence by sentence in students' mathematical problem used in the reasoning for the completion strategy. Statements obtained to support the transition between steps in problem-solving [1]. Students stated that the mathematical procedure he had learned in the early grades has forgotten. However, they are trying to remember mathematical formulas and procedures that may be used in solving the problem.

When students are faced with the problem PS-1, which is a matter of cultivation, they tend to remember the procedure gained while studying cultivation. Conversely, when students find problems PS-2, PS-3, PS-4 then tend to do creative reasoning. This is according to a statement [11], when students are faced with tasks such as textbooks, students solve it by trying to recall facts or algorithms. Such duties do not require conceptual understanding. Instead, the task beyond textbooks mostly resulted in creative mathematical reasoning.

4. Conclusion

The context of agribusiness horticulture help student reasoning in the process of mathematical problem-solving. The reasoning that dominates solving this problem is creative reasoning, both local and global creative reasoning. It implies that the mathematical problems presented in the context of environment and competencies students will affect the thought process that ultimately determines the type of reasoning.

Acknowledgments

Thanks to Mr. Ruhyana Kamal, M.P. and Ibu Yuni Yulian, S.P. for helping during the research process.

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