The role of agricultural contextual knowledge on the mathematical understanding of vocational students

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Abstract. This study aims to analyze the role of agricultural contextual knowledge on the mathematical understanding of vocational students. This study used a qualitative approach with a case study method. The participant were food crop and horticultural agribusiness specialization students of vocational school in Ciamis, Indonesia. Students solve the mathematical tasks in agricultural situations that are integrated with three-dimensional topics to explore contextual knowledge and mathematical understanding. The results obtained are: (1) students' contextual knowledge of agriculture affects the understanding of the task context, and vice versa; (2) there are students who have agricultural contextual knowledge who tend not to be able to integrate it with mathematical concepts; (3) students who are able to solve the task have contextual knowledge, construct all information, and connections with mathematical concepts. These results indicate that contextual knowledge of agriculture can provide a role in mathematical understanding or not depends on the problem of the task and the ability of students in the coherence and correspondence of information, as well as mathematical connections.

1. Introduction

Vocational high school is one of the secondary education levels that prepare students to work. Various knowledge and skills are given to students on integrated subjects, producing output that is expected to be ready to meet the industrial revolution era 4.0. Mathematics subjects included in the field of literacy support students having the ability to mathematical understanding to carry out tasks according to their expertise.

Researches on mathematical understanding at work have been carried out. LaCroix [1] found that most students had difficulty understanding and applying mathematics in solving problems in pipe production. FitzSimons and Boistrup [2] found that workers have limited and high mathematical abilities, but high-ability workers tend not to be able to apply mathematics to their work.

The ability of mathematical understanding in the workplace is very necessary. Mathematical conceptual are important for problem solving in the workplace [3]. Conceptual and contextual understanding is important in the workplace, with conceptual coherence in contextual issues must be done to develop the ability of mathematics conceptual understanding [2].

The discussion of mathematical understanding takes place from year to year. Experts discuss theories about mathematical understanding. Skemp [4,5] suggested mathematical understanding into
instrumental, relational, and logical understanding. Greeno [6] states three criteria of mathematical understanding, namely: coherence, correspondence with true meaning, and connection with general traits. The study of mathematical understanding is more detailed for the role aspects in mathematical understanding is also discussed. Examples are the role of memory in mathematical understanding [7], collecting roles to foster mathematical understanding [8], and the role of knowledge and trust can help students improve understanding mathematically [9].

This research will specifically discuss the role of contextual knowledge of mathematical understanding of vocational high school students in food crop and horticultural agribusiness. As already explained, middle school students have contextual knowledge and skills according to their expertise gained from expertise lessons. Contextual knowledge can be linked to the problems of everyday life in the real world and enter the school situation by presenting problems in their context [10]. In this case, the problem is taken from the phenomena of daily work and is presented in a problem situation at school. Therefore, contextual knowledge in this study is an knowledge of a situation in a field of expertise, where contextual understanding can play a role in mathematical understanding (instrumental, relational, and logical) that students have to solve the problem.

Contextual knowledge becomes important along with the variety of dynamic contexts or situations in the world of work. However, understanding the problem situation and the use of mathematics in the workplace is a source of difficulties [1]. In fact, without contextual understanding coupled with mathematical conceptual and procedural knowledge, it is impossible to produce rules that are in accordance with the reality of the problem [2].

Contextual understanding in this study is analogous to the concept of language understanding used by Greeno [6] to analyze the understanding of mathematical concepts. He explained the concept of mathematical understanding by adopting the theory of language comprehension and procedural knowledge theory. He stated that the concept of understanding refers to the construction of representations of some information by considering the understanding of concepts and relationships between concepts. Greeno [6] states that understanding as a process with criteria, namely internal coherence representation of the level of connectedness of information with other things he knows and correspondence with concepts that are understood.

2. Methods
This research is a case study. The case studied in this study is a contextual knowledge of agriculture that influences the mathematical understanding of vocational school students. The research was conducted on three students XI grade vocational of food crop and horticulture agribusiness. Subjects represent three characteristics of mathematical abilities: low (S3), moderate (S1), and high (S2). The researcher observed the learning process and focused on observing the three participants during the task completion process. Students are given one task situation after the teacher gives sub-topic of three dimensions.

Students are given tasks with the context or situation of agricultural problems on a three-dimensional topic to observe contextual knowledge. After solving the task, interviews were conducted with students to find out the construction of representations of some information presented in task situations that would play a role in mathematical understanding (instrumental, relational, and logical) in solving problems. Data from the results of the answers and interviews of these students were analyzed to determine the role of contextual knowledge of mathematical understanding.

Based on the results of interviews with agricultural teachers and technicians, the agribusiness system applied in vocational schools was more focused on the cultivation subsystem. Other subsystems are only limited to the introduction aspect. On-farm agribusiness, namely cultivation activities that produce primary agricultural commodities (food crop farming, horticulture farming, medicinal plant farming, plantation business, livestock business, fisheries business, and forestry business). In this study, mathematical tasks were designed based on food crop cultivation and horticulture which were integrated with the three-dimensional topic.
3. Result and Discussion

3.1. Contextual Knowledge

Many agricultural situations for mathematical tasks on topic three-dimensions. For example land, bedengan, lanjaran, water discharge, and planting media. We chose land (rice fields) for minapadi, planting media in flower pots, and lanjaran on bedengan. The task situation is assumed to be able to explore contextual knowledge that has a role in students' mathematical understanding.

The first task in this situation is to explore the understanding of the concept of surface area in the three dimensions. Students relate knowledge about installing plastic mulch for minapadi with a three-dimensional surface area according to the task situation. The following are the problem situations presented to students:

"Minapadi (from mina = "fish" and rice) is a form of combined farming that uses paddy fields that are being planted with rice as a pond for cultivation that maximizes the yield of paddy fields. A farmer does a minapadi business on an area of 5 bata. Plastic land mulch will be installed to anticipate water leakage and reduce weed growth. Determine the amount of plastic mulch needed ".

When solving tasks in the minapadi context, initially students tend to be confused in determining the shape of rice fields that have an area of 5 bata. The task is deliberately designed to be an open answer. Students are free to determine the shape of the rice fields. In addition, the bata is an area used in the community, rarely given in school.

Based on the answer sheet and interview from S1 can be interpreted as follows: (1) understand bata in units of length; (2) knowing the width size of mulch sold in the market; (3) sketching rectangles to represent the area of rice fields based on the habits he saw in the community; (4) can show mulch position. The description shows that S1 has contextual knowledge based on the tasks presented and can construct representations of some information, even though there are misinterpretations in bata problems.

Based on the answer sheets and interviews from S2, they can be interpreted as follows: (1) understanding of bata; (2) sketching minapadi land in a rectangular shape; (3) can show the position of plastic mulch. The description shows that S2 has contextual knowledge based on information from the tasks presented.

Based on the answer sheets and interviews from S3 can be interpreted as follows: (1) lack of understanding of bata; (2) states that a circular land with a circle radius is the area of land. The description shows that S3 does not yet have contextual knowledge based on the tasks presented.

The second task in the situation of the planting media is to explore the understanding of the volume concept in the third dimension. Students relate knowledge about planting media to flower pots with three-dimensional volumes according to the task situation. The following are the problem situations presented to students:

"A farmer plans to plant flowers in a pot. The height of the flower pot is 50 centimeters, the top and bottom are square shaped with sides of 4 and 20 centimeters respectively. Planting media is a mixture of soil, organic fertilizer, and husk charcoal with a ratio of 2: 1: 1. How much mixture of soil, organic fertilizer, and charcoal are needed to fill the flower pot? ".

Students' knowledge of planting media to fill flower pots based on their experience. They tend not to relate it to the concept of three-dimensional volume. S1 states that to fill flower pots using doses made specifically to compare the mix of planting media, S3 estimates the mixture in a ratio of 2: 1: 1 to fill the flower pot to the full.
The third task in the ‘lanjaran’ situation is intended to explore the understanding of the concept of angles in the third dimension. The following are the problem situations presented to students: "A farmer will cultivate cucumbers. He prepared bedengan and lanjaran shaped like Figure 1. A lanjaran has a length of 2 meters. The bedengan width is 1 meter. Determine the angle formed by two lanjaran at the top (tied by a rope)".

Figure 1. The design of ‘Lanjaran’

To solve the task in the context of the lanjaran, all students can show the location of the angle on the lanjaran. Students tend to ignore the length of the lanjaran in real situation, there are parts that are bound and parts that enter the ground. Thus, the actual length of the lanjaran is less than two meters. In this case, students do not have the complete coherence and correspondence capabilities of information. The following is the S2 answer in Figure 2.

Based on the presentation of the results of the tasks given to students, it can be seen that the students' contextual knowledge of agriculture based on the student experience. Contextual knowledge influencing is also influenced by institutional and cultural characteristics [11], also supported by reasoning [12]. Students with agricultural knowledge can construct various information to show which parts will deliver on completion of the task. Therefore agricultural knowledge affects the understanding of the context or task situation, and vice versa.

Figure 2. Answer of Lanjaran context from S2

3.2. Mathematical Understanding

Students' mathematical understanding is observed to know relational, instrumental, and logical understanding [5]. Relational understanding is the ability to deduce specific rules or procedures from more general mathematical relationships. In the case of minapadi, it is expected that students can deduce the three-dimensional surface area rules from the task context. In the case of planting media, it is expected that students can deduce the three-dimensional volume rules from the task context. In the
case of lanjaran, it is expected that students can deduce the angle rules in the three dimensions. Observation on instrumental understanding to know how to apply rules that are remembered by students. Logical understanding to find out how students connect symbolism and mathematical notation with relevant mathematical ideas and to incorporate these ideas into a chain of logical reasoning.

Mathematical understanding of S1 in solving tasks can be described as follows: (1) in Minapadi's tasks, S1 can deduce surface area rules according to the task context but has not combined all mathematical ideas to achieve a complete solution. (2) in the task of planting media, S1 tends to be unable to deduce the rules of three-dimensional volume. (3) in the lanjaran tasks, S1 can determine the cosine rules to obtain the desired angle, combine mathematical ideas to obtain a solution.

The mathematical understanding of S2 in solving tasks can be described as follows: (1) in the task of minapadi, S2 tends to be unable to relate contextual knowledge to the rules of surface area that they already know. (2) in the task of planting media, S2 makes its own rules to obtain completion of tasks with mathematical ideas that he obtained from the environment. (3) in the task of lanjaran, S2 can combine mathematical ideas and determine the rules of cosine to obtain a solution.

S3 mathematical understanding in solving tasks can be described as follows: (1) in Minapadi's task, S3 tends to be unable to determine the surface area rules according to the task context. (2) in the task of planting media, S3 tends to be unable to deduce the rules of three-dimensional volume. (3) in the lanjaran task, S3 can determine the cosine rules to obtain the desired angle but has not been able to combine mathematical ideas as a whole to reach a solution.

Based on the explanation of students' mathematical understanding in completing the task, it is clear that mathematical understanding has a role in solving the task. Mathematical understanding links several mathematical concepts and their operations [13], adopts procedures when from variations in data or language or available contexts [14]. Therefore a relational, instrumental, and logical understanding becomes an important key to success in solving tasks reasonably.

3.3. The Role of Contextual knowledge on Mathematical Understanding

Completion of tasks in the context of everyday life or a particular field involving mathematics is not an easy thing. Contextual, conceptual, and procedural knowledge is needed to be applied productively in problem situations [10]. All three have their own roles but cannot be separated to achieve success in getting a reasonable solution.

Only contextual knowledge is not enough to solve problems. S2, for example, has knowledge of the agricultural context, three-dimensional concepts, and good mathematical procedures so that they are identified as students who have high mathematical abilities. Partial agricultural and mathematical knowledge does not lead to resolving the problem completely.

Contextual knowledge is a bridge between traditional mathematics and school mathematics (conceptual and procedural) [10]. In this study agricultural knowledge has an important role or is not very dependent on individuals. Students who can connect information on tasks with the right mathematical concepts will reach a solution. In this case, contextual knowledge plays a role in a relational understanding, namely connecting mathematical ideas to absorb the information presented in the context of agriculture to get a conclusion about the rules or procedures to achieve a solution. Therefore, the core of the role of contextual knowledge in this study is the bridge from the agricultural context to the mathematical context.

There are several challenges to completing contextual tasks in this study. Knowledge of the context of agriculture is apparently not enough to complete tasks that are assumed to be complex by students. Therefore creativity is needed in completing tasks. Creativity in analyzing arguments and decision making needs to be done by students to overcome the high level of complexity, challenges, and understandings [15]. In addition, understanding problems is an essential part of the process of solving problems that will affect other problem-solving processes [16], so that they do not see a problem context separately.
Finally, students who have contextual knowledge, coherence and correspondence of all information, connections with mathematical concepts tend to be able to complete tasks. These results indicate that contextual knowledge of agriculture can provide a role in mathematical understanding or not depends on the problem of the task and the ability of students in the coherence and correspondence of information, as well as mathematical connections.

4. Conclusion
Knowledge of the context of agriculture provides a very important role in mathematical understanding to achieve a reasonable solution. However, the agricultural and mathematical contextual knowledge possessed by students who are partial in nature cannot lead students to reach the expected solutions. Students' ability in the coherence and correspondence of information from the tasks presented and mathematical connections are very important elements to link the role of the agricultural context and mathematical understanding.

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