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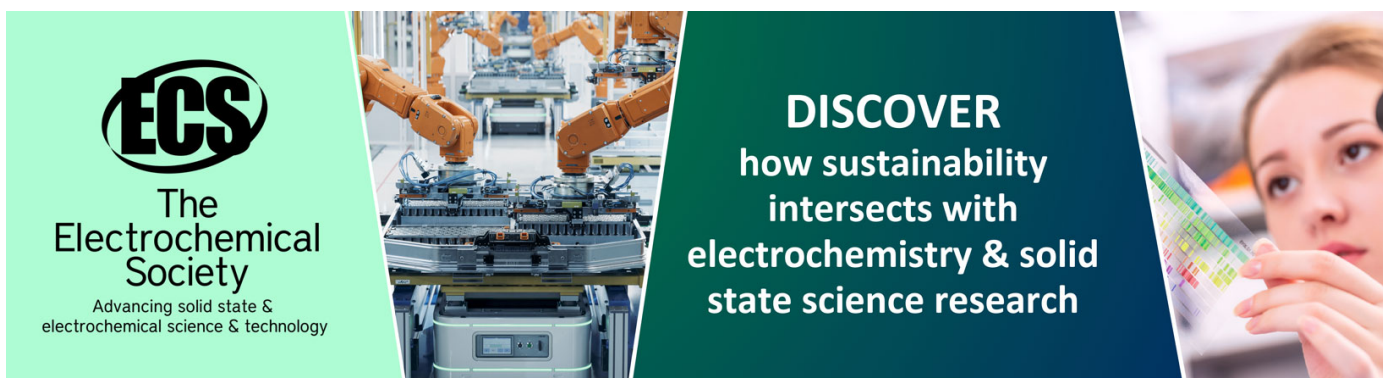
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Mathematical Problem Solving Strategy based on Conceptual Thinking

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Abstract. Problem solving is an important competency for learners. The importance of this competence contained in the curriculum of education in Indonesia. Math problems have difficulty level that are high enough. The more complex concepts involved in a problem, the higher difficult level of the problem. Thus, solving mathematical problems require the ability to associate many concepts into a united concept to bring up as a key concept. The key concept results an appropriate problem solution. This paper describes the important stages students did in applying conceptual thinking in solving mathematical problems. This study is explorative descriptive study by qualitative approach. The subject is the male students of mathematics education department in Universitas Negeri Makassar. The instruments are mathematical problem solving tasks and an interview. The result describes the importance steps in solving mathematical problems based on conceptual thinking. Those steps are (1) describing problems, (2) associating problems, (3) determining key concepts, and (4) formulating solutions.

1. Introduction

The Ability of problem solving is one of the critical competencies that should be owned by the learners. This competence contained in applicable curricula in Indonesia at the moment. However, the reality on the ground suggests that learners still have difficulty in solving the problem. One of the reasons is a matter of mathematics that does not have yet a fixed procedure while students used to think procedurally. Approximately 85% of students complete the procedural questions, but only 30% complete conceptual questions [1].

The complexity of the mathematical problem generally involves a variety of concepts. For that, the troubleshooter should have the ability to relate these concepts into a unified concept. This will make it easier for learners to look at the issue as a whole, so, that it can determine an important concept of the unity of concepts. Based on important concepts that will bring forth a draft resolution which proper.

In general, learners have not been using conceptual thinking in solving the problem. They are still accustomed to solve using the steps of completion procedurally. This makes trouble if encountering problems of mathematics do not have a fixed procedure. This poses difficulties for learners in solving math problems. Since the completion of math problems in general does not yet have a fixed procedure. Mathematical problem solving is very dependent upon the concepts involved in the issue.

With conceptual thinking, learners will be more directional in solving math problems. They do not try to use the system in solving the problem. But they already have a draft solution based on the relation between the concepts involved in the issue. This happens because they are able to see the



problem as a whole through the concept of connectedness. Conceptual thinker able to recognize characteristics in a new situation and apply prior knowledge that is relevant to the new situation. (Pushkin) Conceptual thinking is very important for learners in an attempt to perform troubleshooting effectively and efficiently.

2. Conceptual Thinking

The importance of conceptual thinking has been around since a long time. Cultivate the habit of thinking conceptually considered important since the age of Plato and Plato's teacher i.e. Socrates. Aristotle as a great philosopher, taught for 20 years in the school of Plato's thought in terms of concept [2].

Conceptual thinking is the person's ability to understand a situation or problem by looked at it as one integrated, includes the ability to identify patterns of linkages between issues that do not appear clearly, or the ability to identify the main problems underlying the complex situation [3,4]. This is the ability to see things as a whole, identifying key issues, see the relationship and interesting elements together into a coherent framework [5,6]. Another view of conceptual thinking that is the thought process by using a concept that has been owned by the results of previous lessons in solving a problem [7].

As for the characteristics of the procedure on the level of solving meta-strategy conceptual thinking is as berikut [8]: (a) create a picture (image) in his mind about the issue as a whole, (b) analyse it to discovers the core structure, (c) see the key elements or relationships in those situations, it's a manyangkut insight into the relationships between the elements given by the unknown, (d) so the key elements or key relationship is found, he built a strategies breakdown problem.

3. Method

Researchers explore the subject's conceptual thinking in completing math problems. In exploring the conceptual thinking process of the subjects, researchers get the descriptive data in the result form of the completion problem solving math tasks and deepened through interview-based tasks.

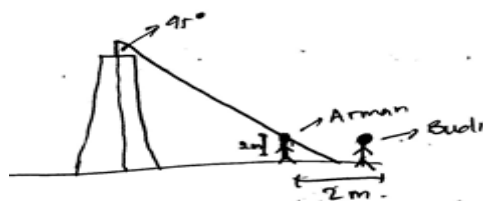
The researcher is the main instrument. Auxiliary instruments used are: (a) a test of math skills, that are used to specify the subject, i.e. score ≥ 80 , (b) problem solving task, which is used to expose the conceptual thinking subject in solving math problems.

The subject in this study are students of mathematics education Makassar State University 2016/2017 the year-sex male. Data collection of the subject is done through the giving task solving math problems and then conducted an interview-based task completion results so that data obtained more complete and profound.

Data that are already collected are analyzed to obtain an overview of conceptual thought process students. The data analyzed are data which are already valid. The valid data obtained through triangulation process time. In addition, the member also chek to add to the credibility of the research data.

4. Results

The first stage, subject complete math problems by drawing the situation a problem. Original image is created by using real objects that exist in the matter. The situation can be seen in the following figure.



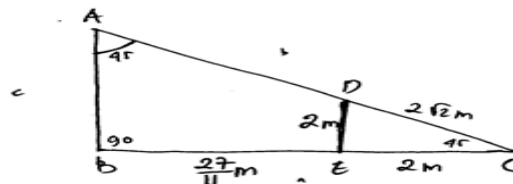
The subject should draw the situation to the problem. He felt the difficulty if only imagined the description of the problem situation. The object is drawn to resemble the original but still given

mathematical object elements in the figure. As in the figure of the Tower, although according to the actual form, but he still gives the mathematical identity in these figures such as a perpendicular line

In addition to making an overview of problems in viktorial, the subject also should improve his understanding of the problems by presenting symbolically from the hard part that is described in viktorial, such as the following

$$\begin{aligned}v &= 9 \frac{3}{7} \text{ m/menit} \\t &= 4 \text{ menit} \\s &= v \cdot t = 9 \frac{3}{7} \cdot 4 = \frac{108}{7} \text{ m} \rightarrow \text{KO}\end{aligned}$$

After the problem is already described as a whole, either in viktorial or symbolically, then create a figure. The geometry figure of the problem situation is presented as follows:



The geometry figure from a problem separate from the description of problems that contain the realistic object. This is intentionally conducted because he still wants to complete the figure with some mathematical identities. This figure has a slightly different with the description of problems at the beginning. This is caused by the presence of the subject assumption when they were starting to draw.

The subject is trying to understand the situation the problem completely by looking at the relation between existing concepts in the figure. Interconnections between these concepts emerge to an important concept as the basis for making the step solve problems. Thus the subject are looking for the following values.

$$\begin{aligned}\text{KO} &= \pi \cdot d \\ \frac{108}{7} &= \frac{22}{7} \cdot 2BE \\ 2BE &= \frac{108}{7} \cdot \frac{7}{22} \\ BE &= \frac{108}{44} = \frac{27}{11} \text{ m} \\ DC &= \sqrt{2^2 + 2^2} = \sqrt{8} = 2\sqrt{2} \\ BC &= \frac{27}{11} + 2 = \frac{49}{11} \text{ m}\end{aligned}$$

Having received the required values, then search for:

Karena sudutnya bersesuaian, berarti $\triangle DEC$ sebangun dengan $\triangle ABC$
 $\angle C = \angle C = 45^\circ$, $\angle B = \angle E = 90^\circ$, $\angle A = \angle D = 45^\circ$. Sehingga.

$$\frac{EC}{BC} = \frac{CD}{AC}$$

$$\Rightarrow \frac{2}{\frac{49}{11}} = \frac{2\sqrt{2}}{AC}$$

$$AC = \frac{2\sqrt{2} \cdot 49}{11}$$

Finally retrieved the bullet travel time as follows.

Waktu yg. diperlukan peluru mengenai target:

$$\begin{aligned}t &= \frac{s}{v} = \frac{\frac{90\sqrt{2}}{11}}{9\frac{3}{7}} = \frac{90\sqrt{2}}{11} \times \frac{1}{2\sqrt{2}} = \frac{90}{22} = 4\frac{10}{22} \\ &= 4\frac{5}{11} \text{ detik}\end{aligned}$$

5. Discussion

The subject read sentence by sentence while understanding the meaning. Every sentence he read constantly imprinted in his mind and try to associate with the concept that he already had. If the sentence in accordance with the concept that he had then immediately pour it into a piece of writing. This is conducted, in order to the problems they face become concrete. In other words, he is trying to make the problem becomes manifest through an image.

The figure of the first issue is made by the subject that are containing real objects according the actual circumstances. The objects that exist was drawn to resemble their original form, for example a human object is drawn to resemble humans. This is conducted in order that the description of the problem situation that is made looking like real subject that makes it easy to understand the real problem.

Although the figure that is made is resemble with it's original form, but the figure still has elements that relate to the description in the geometry. For example, in the figure of the Tower, the perpendicular line in the figure is the height of the tower.

There is some information in problems that can be presented by drawing an object. To help presenting the information, it needs a description of symbolic problem. Describing symbolically is more abstract and difficult to be explained. It requires a good analyst skill to understand it. In this case, the subject was able to make the description of the symbolic well, in fact he immediately completed a section even though it is not the time to make a solution. This is conducted because he has managed to connect between the problem with the concept that he had. the concept is the distance concept, that is time multiplied by the velocity.

Before completing the problems, firstly, the subject create the geometry figure from the problem. The figure based on problem situation is created in the beginning. The figure is very helpful to understand the whole subject. The figure is created separately from the figure of problem situations. This is conducted because the subject feel easier to see problems if the figure separate from the problem situation's figure. If the figure is created with a problem situation's figure, the subject are being distracted by real objects that exist, so that makes it difficult to understand the mathematical problems.

Based on the geometry figure, the subject is trying to look at the problem as a whole and the relation between the concepts. The subject notice that there is important concept in figure. The concept is the congruence of two triangles. This concept is important because the the concepts in problems relate with the congruent concept of two triangles. In other words, the concepts that are in problems are associated by the congruent concept of two triangles in figures. This concept is known as a key concept or important concepts that is the basis to design problem solving.

Based on the key concept, the subject began to think backwards, starting with the elements are sought in the problems until the unknown elements that are required in the process in solving problems. In this way, the subject can determine what parts need to be sought in advance. When it was obtained the value of required elements then the solution of the problem is obtained.

6. Conclusion

The problem involves a lot of math concepts. By thinking of the structure of the concept that build problem will bring up a key concept that unites the concepts. A key concept is the basis for determining the strategy for solving problems. With the selection of the right strategy then making the mathematical problem resolution is better.

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