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IMPROVING STUDENTS' METAPHORICAL THINKING ABILITY OF MATHEMATIC IN SENIOR HIGH SCHOOL THROUGH SCIENTIFIC APPROACH IN THE 2013 CURRICULUM

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Abstract

This study was a quasi-experimental study aimed to examine students' metaphorical thinking ability in senior high school through scientific approach in the 2013 Curriculum. The ability of metaphorical thinking is the ability to think that bridges mathematical ideas of students with the existing phenomena, modeling with students' interpretation. These capabilities provide opportunities for students to explore knowledge in learning mathematics. Metaphorical thinking ability measured includes the capability of connecting, inventing, discovering and applying. The result showed that there was a significant increase in the aspect of invention and discovery, but it did not show a significant increase in connection and application aspects.

Key words: **scientific approach, metaphorical thinking**

INTRODUCTION

Of some determinant factors of progress of a nation, 90% of which are factors of human resources playing an important role. 45% out of human resources factor was ability in the form of innovation and creativity (Sunito, 2013: 49). Humans are born with the ability to be creative, explore the potential, learn, search, and also the ability to find. In fact, only a small percentage of people who can transform ideas, knowledge, and experience even though they have the potential to get creative and innovative thinking. People have a fear of their own thought, so that in the end they are afraid of being creative.

The ability of creativity, innovation, collaboration, connection, communication and others is a structured process in a person. This ability does not appear by itself, but shaped by the environment that supports the development itself. One's conceptual system is metaphorically the concept of knowledge that greatly affects a person's ability to translate the world of reality that he faces led to the systematic and measurable reasons. The abilities mentioned above refers to the process of metaphorical Thinking (Wahab, 1995: 67).

Metaphorical Thinking emphasizes on the activities that change something from the state of matter and meaning of a state to the other. The accuracy and speed of the process of interpretation is maturing process of some one's metaphorical thinking ability. The linkage process of interpretation of a phenomenon or the result of observation will affect a person's intelligence, creativity and innovation. Metaphorical thinking digs person's ability with his brilliant ideas. There are four stages of the metaphorical thinking process according to Siler (Sunito, 2013: 61) which includes: connection, discovery, invention, and application.

Given the importance of the role of metaphorical thinking ability in fostering students' innovation and creativity, and need of students to be equipped with the ability to create and innovate, hence, the learning, especially of mathematics, methods and approaches that support

this capability are necessary to develop. The possible approach is an approach that allows them prioritize connectivity, communication, creativity, discovery, application, etc..

One possible learning approach to improve the ability of metaphorical thinking and being developed in a number of schools today is scientific approach. This approach includes the steps of: observing, questioning, associating, eksperimenting, and networking. This approach expected to learning is one approach that can explore the creativity and curiosity of students. Given the metaphor of thinking also contains aspects of creativity (invention and creation) and curiosity (connection and application), then the problem in this study is formulated as follows:

1. Is there an improvement of students' metaphorical thinking ability though scientific approach:
   a. Overall
   b. For each of its aspects, namely: connection, application, discovery and invention
2. How is the implementation of scientific approach in the teaching of mathematics and effort to make it effective?

This research aims to analyze students' metaphorical thinking ability using scientific approach to both overall and each of its aspect. This research is also expected to provide input for the teachers in the application of scientific approaches that can be explored competencies expected of students can be optimally achieved.

RESEARCH METHOD

This study was a quasi-experiment conducted on 83 high school students. First of all students learnt to use the usual approach to the material, and then were given a test of metaphorical thinking on the material including the capability of connection, creation, discovery and application. Then the students learnt using scientific approach to another material and after that granted another metaphor thinking tests on the material. The data obtained were then processed using SPSS to see an increase in students' metaphorical thinking skills in every aspect.

The example of metaphorical thinking test used in this study was as follows:

1. Connecting ability
   Consider the collection of the following words:
   Equation, set, range, linear, domain, absolute value, elimination, substitution, co-domain, reflective, variable, equal to, arrows diagrams, symmetric, constant, Cartesian diagram, the method of Sarrus, Order, transitive, antisimetris, Identity, equivalence, installation , transpose, exactly one, the determinant, the set of sequential pairs
   a. Which of these words are associated with the material of Relations and Functions!
   b. Group the words on the material of relations and functions based on the following sub-materials:
      1) The definition of relation
      2) The properties of relation
      3) The definition of function
      4) Diagrams of relation and function
      5) Discovery
2. Discovering
   Based on the test item number 1, arrange and explain why the words are associated with sub-material of relations and functions on number 1), 2), 3), and 4)!

3. Invention
   Draw on a diagram of the relationship of the words in explaining the material of relations and functions!

4. Application
   Consider the following problems:
   a. By the Iedul *Fitri*, Anisa was told by her mother to the market to buy 50 pieces of *ketupat* wrap and 4 kg of chicken meat. She had to pay Rp 125.000, -. At the same time Windy also was told by her mother to market to buy 30 pieces of ketupat wrap and 2 kg of chicken meat and she has to pay Rp 90.000, -. State the mathematical model to describe the above problems!
   b. A group of children which consists of 5 members, namely {Arif, Dila, Merry, Burhan, Yesi} aged 6,7,7,8,9 respectively. Determine the area of origin, friends and local area resulted from the matching of the group of children and their age.
   c. Draw a diagram matching the children's name with their favorite foods based on the following data:
      Ivan and Dita, favorite food is Bakso (meat balls)
      Diana, favorite food is Fried Noodles
      Fitri, favorite food is Sate
      Andriani, favorite food is Soto
      No child likes Pizza.
   d. In early 2011 Krishna saved money amounting to Rp 500,000, - in Bank A. He has saved money for 2 years. How much money does Krishna have at the end of 2013 if the bank gave a compound interest rate of 8% a year?

Which of the problems associated with the use of the concept of relation and function? Explain and solve the problems related to the relation and the function!

RESULT AND DISCUSSION

From the result of metaphorical thinking test, the obtained data are as follows:

Table
The result of metaphorical thinking test

Aspect	Test Type	N	$\bar{x}$	S	df	p
connection (SMI=5)	Pre test	83	3,73	0,56	81	0.070
	Post test	83	3,56	0,66	81	
creation (SMI=5)	Pre test	83	3,52	0,62	81	0.020
	Post test	83	3,84	0,54	81	
discovery (SMI=5)	Pre test	83	3.79	0,77	81	0,003
	Post test	83	4,04	0,66	81	

Aspect	Test Type	N	$\bar{x}$	S	df	p
Aplication (SMI= 5)	Pre test	83	3,73	0,55	81	0.911
	Post test	83	3,77	0,57	81	
Overall (SMI=20)	Pre test	83	4,25	0,55	81	0.015
	Post test	83	6,15	0,65	81	

From the above results it can be concluded that there is a significant increase in the aspect of creation and discovery, but it does not show a significant increase in connection and application aspects. And overall there is a significant increase in students' metaphorical thinking ability.

The implementation of scientific approach in the field of mathematic learning is effective only on some subject matter. For certain materials, especially materials that are still new to the students, the teacher seem sill confused to fully implement this approach. Teachers were also a little inconvenience to translate the steps of the scientific approach both in written form of students' worksheets and in the worksheet and teaching materials taught verbally by teachers. There is a common thread between the steps of scientific approach with the concept of metaphorical thinking. Faiq (2013) states that the learning process implementing scientific approach will touch the 3 domains namely attitude (affective), knowledge (cognitive), and psychomotor skills. The affective domain takes substance transformation or teaching materials so that learners know "why". Cognitive domains takes substance transformation or teaching materials that students know "what". The psychomotor domain takes substance transformation or teaching material that students know "how".The final result is the increase and the balance between the ability to be a good man *(soft skills)* and a man who has skills and knowledge to live a decent *(hard skills)* of learners that includes aspects of attitudes, skills, and knowledge competency.

Kemendikbud (2013) states that the 2013 curriculum emphasizes modern pedagogical dimension in learning, that is using scientific approach in the study referred to includes observing, asking, trying, processing, presenting, summarizing, and creating for all subjects. For the subjects, materials, or certain situations, so perhaps this scientific approach is not always appropriate procedural to apply. In this condition, of course, the learning process must continue to implement the values or scientific nature and avoid nonscientific values or attributes.

While the concept of thinking metaphor developed Careira (2003) can be described as follows:

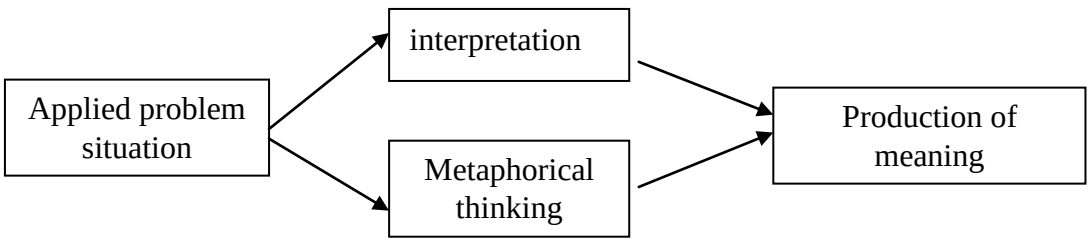

Diagram
Concept of Metaphorical Thinking

Form of metaphor conceptual includes:

a. Grounding methapors is the basis for understanding the mathematical ideas connected with everyday experience.
b. Linking methapors*:* making connections between two things: choosing, affirming, allowing, and organizing the characteristics of the main topics to be supported by additional topics in the form of metaphoric statements.
c. Redefinitional methapors*:* Redefining the metaphors and choose the most suitable with the topic to be taught.

Lakoff and Johnson (1980) says: "Our conventional ways of talking about arguments presuppose a metaphor we are hardly ever conscious of. The metaphor is not merely in the world we use … it is in our very concept of an argument. On the contrary, human thought processes are largely metaphorical. This is what we mean when we say that the human conceptual system is metaphorically structured and define". According to Holyoak & Thagard (1995), metaphor moves from a concept that is known by students to another concept which has not been known or being learnt by the students. Metaphor depends on a number of characteristics of the concept and the things which is metaphored. Taylor (in Siregar, 2004) states that metaphor is not understood as a speaker's mistake on the rule of language competence. Vice versa, cognitive paradigm considers metaphor as a means of conceptualizing the domains of abstract experience and it is not brought to the intimate and concrete domain.

Siler (Sunito, 2013: 61) says that there are four stages in the process of metaphorical thinking, namely the connection *(connection),* discovery *(discovery),* creation *(invention)* and applications *(application.* So from the above description it should all be metaphorical thinking process can be developed by scientific approach, but in reality only aspect of discovery and invention which significantly increased. Based on field observations of the writer in this is because compared with the usual approach, scientific approach more explores the creativity of students in the discovery and invention. In accordance with the opinion of Kemendikbud (2013), the scientific approach highlights the dimensions of observation, reasoning, discovery, validation, and an explanation of the truth. Accordingly, the learning process should be carried out and guided with values, principles, or scientific criteria.

CONCLUSION AND SUGGESTION

1. Conclusions

Based on the analysis of data it can be concluded that:

a. There is a significant increase of the overall students' metaphorical thinking ability.
b. There is a significant increase in aspect:
    1) Invention
    2) Discovery
c. There was no significant improvement in aspects:
    1) Connection
    2) Application
d. Scientific approach in the study of mathematics cannot be fully implemented in all matter. Teachers should be good at choosing the right strategy in combining scientific approach with other approaches so that the material presented can be delivered effectively through various combinations of this approach.

2. **Suggestions**

Based on the research results and conclusions, the writer suggests the followings:

a. To explore the metaphor thinking skills, mathematics learning should further strengthen students' understanding of basic concepts in advance, so that the strength of understanding of this basic concept then becomes the basis for students to administer connection, application, discovery, and invention.
b. For a more effective implementation of scientific approach, teachers should first sort out the material and do the *chapter design* before learning is implemented so they can identify which topic can be taught using scientific approaches fully, started from finding until applying the concept, which can be applied to the discovery of a concept only and which can be applied to application only. To a particular topic, this approach can be combined with any learning approach.

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