STUDENTS' UNDERSTANDING IN LEARNING TRIGONOMETRY USING MNEMONIC METHOD

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Abstract
Mathematics is one of the disciplines that trains people to form the ability to think logically, critically, creatively and dynamically. Especially in high school, mathematics contains a lot of terms, formulas, and rules. Therefore, there should be efforts to increase specific cognitive abilities which in this case referred to the ability of mathematical understanding. One of the methods that can facilitates students to remember the formulas and terms in math easily is mnemonic method. This method can be used to support the utilization of memory concepts and mathematical formulas in specific ways. This study aims to test the learning material of sine and cosine addition by implementing the mnemonic method in one high school in Aceh Besar. The data collected are in the form of mathematical comprehension tests, worksheets, and questionnaires. Based on the test results, it can be concluded that the students' mathematical understanding of sines and cosines addition are in a very good category. However, the students still have difficulties in writing a conclusion on how to remember the formula of sine and cosine addition, it is easier for them to communicate it verbally. Meanwhile, based on the questionnaire result, it shows that the students' responses to learn sine and cosine addition by using the mnemonic method are absolutely positive.

Keywords: *Mathematical understanding, mnemonic methods, trigonometry, sine and cosine addition.*

INTRODUCTION

Mathematics education is an important aspect in improving the quality of human life. Math is an intact building of a collection of concepts that are related to each other. It is also mentioned in Permendikbud number 59 of 2014 which states that some of the characteristics of mathematics in the learning process are abstract, logical truth, multilevel and continuous, interrelated concepts, using language symbols, and can be applied to other fields.

According to Syahbana (2013), to understand and master Math, it is necessary to improve the cognitive ability which is mathematical understanding in learning mathematics. *Understanding* is the translation of the word 'understanding' (Sumarmo, 1987), which is defined as the meaning of the absorption of a material being studied. Teachers will surely expect the comprehension reached by their students are not limited to the understanding of connecting only. The concept is defined as an abstract idea that can be used to classify a set of objects (Depdiknas, 2003, p. 18). Thus, the understanding concept can be defined as the students' ability to explain the concept that has been studied and to be able to use and develop the concept in different situations.

Ruseffendi 2006 claims that there are three kinds of mathematical understanding, namely: translation, interpretation and the extrapolation. Meanwhile, according to Skemp and Pollatsek (in Sumarmo, 1987, p. 24) there are two kinds of understanding of the concept, which are instrumental understanding and rational understanding. Instrumental understanding can be interpreted as an understanding of the separated concept and formula memorization only in doing the simple calculations, whereas the rational understanding contained one scheme or structure that can be used in a wider problem solving matter. An idea, a fact, or a mathematical procedure can be fully understood if it is associated with a number of strength connection network.

The indicators of the mathematical understanding mentioned by National Counsel of Teachers of Mathematics (2000) can be seen from the ability to restate the learned concepts, the ability to classify objects based on whether or not they fulfilled the requirements to form the concept, the ability to apply the concept of an algorithm, the ability to provide an example of a concept that has been studied, the ability to present concepts in various forms of mathematical representations, the ability to link the various concepts (internal and external math), and the ability to develop a sufficient enough requirements to form a concept. The material of the abstract math requires a certain material transferring technique so that the material can be accepted and understood by the students. Students find it difficult to learn Trigonometry. Besides of having certain rules that must be memorized, Trigonometry also seems to be unused in daily life activities (Wiyartimi, Rahayu & Ratnaningsih, 2010).

Moreover, the inadequate use of learning media and inappropriate use of learning method and model can make students less interested in learning mathematics, especially trigonometry. One of the efforts that is considered to solve the problems above is to adopt the mnemonic method. According to Wojowasito and Wasito (1980, p. 2), Mnemonics derived from the Mne"monics which means intelligence of memorizing. The essence of this method is the imagination and association. Suharnan (2005, p. 15) defines mnemonic methods as a learned strategy to optimize memory performance through exercises. Suharnan is well aware that these techniques need to be practiced to master. While Nur (2011) states that mnemonic helps to organize the information that reaches the working memory in a known pattern such that the information is more easily matched to the pattern of the scheme in the long term memory. To make it shorter, Higbee (2003, p. 4) defines mnemonic as a method to help memory.

Based on these definitions, it can be concluded that the mnemonic is a method to make it easier to remember something. In other words mnemonic means a method for utilization of memory in certain ways.

Some mnemonic techniques according to Joyce that can be used to remember are:

- Loci Method is a method that involves visual memory areas to remember everything which is in the place and then connect each part so that it becomes a single unit / combined intact;
- Mnemonic Acronym System is the use of each first letter of a group of words (sentences) into a new word, for example ASTC is an abbreviation of the names of the angle that is positive in each quadrant (A: All / all is positive in the quadrant I, S: sin which is positive in quadrant II, T means the tan and C means Cos which is positive in the next quadrant);
- Mnemonic Acrostic System is the use of each first letter of a group words and abbreviations in syllables thus make a sentence. However, acrostic does not always use the first letter and also does not always produce stands in the form of syllabe or phrase, for example *sindemi, cossami, tandesa* which stands for comparison of trigonometry in a right triangle; another example is the abbreviation of *intersimin* (integral sin worth min).
- Method of keywords, where the alive imagination put on pronouns.

DeLashmutt (2007) states that "Mnemonic devices are of two main types: organization mnemonics and encoding mnemonics. Organizational mnemonics organize and interrelate new information in memory so information can be later recalled. Encoding mnemonics are used to transform low-imagery, abstract material into more memorable forms before an organizational mnemonic is used to store the information in memory". Meanwhile, according to Maghy (2015) there are three main techniques of mnemonic namely: the method of loci, the pegword method, and the keyword method.

Sunar (2015) mentions there are some benefits to use mnemonic, specifically: First is to facilitate the memorization of the existing subject matter as well as to help students remember information more quickly, accurately and keep it longer, second is to automatically encourage students to be more interested in learning, because children are trained to create a story, an imagination, a rhythm and picture that goes along with learning material so that they are able to maximize the learning time and pursue targets more easily and efficiently, and the last is to support the interesting learning programs that can and should be implemented in class. Mnemonic can motivate students to study harder so they can achieve optimal learning results and overcome the barriers in learning. Based on the background above, the research questions are: how are the students' understanding on the material of sines and cosines addition with the application of mnemonic methods and how are students' responses toward the way of memorizing the formula of sines and cosines addition by implementing the mnemonic method.

METHODS

This study was conducted to test the learning material of sines and cosines addition by applying the mnemonic method in a high school in Aceh Besar. The research instrument used were worksheets and tests to determine the level of students' understanding on the material of sines and cosines addition. Afterwards, a questionnaire is used to determine the students' responses toward the learning. Data obtained from the results of tests and worksheets were analyzed based on the assessment criteria created by Permendikbud 104 2014.

Table 1. Criteria of assessment by Permendikbud 104 of 2014.

Scale	Predicate
86 – 100	Very Good (A)
70 – 85	Good (B)
59 – 69	Fair (C)
≤ 55	Poor (D)

Students' questionnaire responses were analyzed based on the Likert scale. In measuring the Likert scale category, the answers are given weight or equated with quantitative values 4, 3, 2, 1 for positive questions and 1, 2, 3, 4 to the negative question. In this study, for the positive question will be given a score of 4 for strongly agree, 3 to agree, 2 to disagree and 1 for strongly disagree. As for the negative questions were scored on the contrary that a score of 1 for strongly agree, 2 to agree, to disagree 3, and 4 for strongly disagree.

Criteria for the average score according to Nasution and Suryanto (2007, p. 927) for the students' response is as follows:
- 3 < average score of ≤ 4 = very positive
- 2 < average score of ≤ 3 = very positive
- 1 < average score of ≤ 2 = negative
- 0 < average score of ≤ 1 = very negative

RESULTS AND DISCUSSION

Learning activities by implementing the mnemonic method were conducted on April 27ᵗʰ, 2016 on the material of sines and cosines addition toward high school students in Aceh Besar. The learning activity started with motivating students in the early activities learning by looking at power point slides. Then the learning is proceed to the activity of asking and answering questions between teachers and students on issues related to the comparison of trigonometry in daily life that can later lead students on the learning material of sine and cosine number. Activities of 5M (*Mengamati, Menanya, Menggali informasi, Mengasosiasi, dan Mengkomunikasikan*) means Observing, Asking, Finding out information, Associating, and Communicating are performed on core activities and then the feedback and the assessment were carried out at the end of activities/cover.

The classroom atmosphere during the teaching and learning process was conducive because the students were active when working on worksheets. The problem at the beginning of the learning process is that the students are still confused about what to ask after looking at the slides, but the students are already active in rsponding to a teacher's question, doing worksheets and

presentations. According to the writer, the students' curiosities regarding the problems of trigonometry are very good.

If the terms of the achievement of learning objectives can be inferred as those who has been reached, then it means that most students have been able to find the sines and cosines addition formula due to the aids of props in the videos, as well as the students ability to answer questions by applying the formula. However, the students are still having difficulty in writing a conclusion about how to remember the formula of sine and cosine number, they are more proficient when communicating the conclusion with the words.

The pictures below are examples of the students' answers on how to remember the addition sines and cosines formula using mnemonic method:
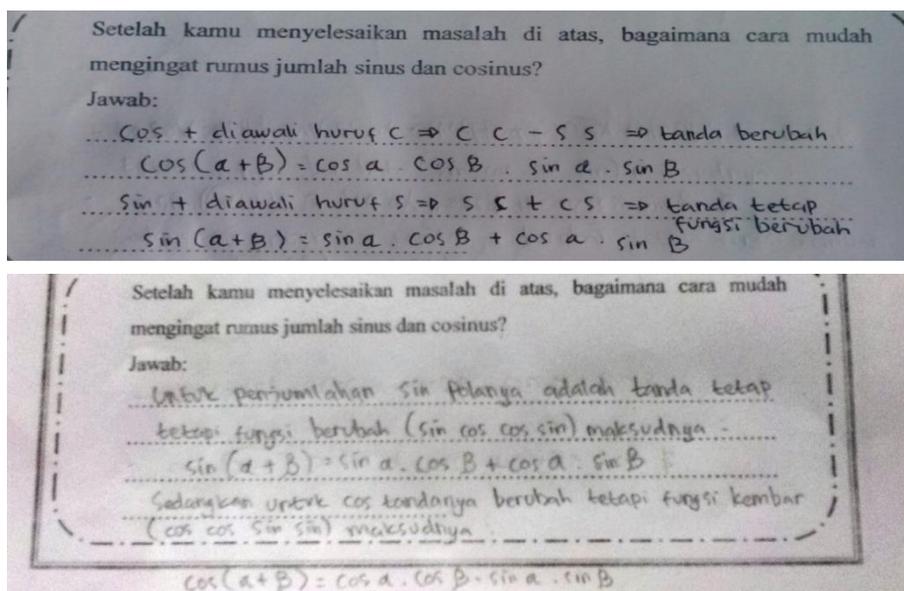
Figure 1. Examples of the students' answers using mnemonic method.

From the test results, it was found that the students often use mnemonic techniques in mentioning formula of sines and cosines addition in form of Acronyms and acrostic techniques.

Based on the students' answers on the test and the result of data analysis on the students' understanding related to the material of sines and cosines addition by applying mnemonic method, it can be concluded that:

- Students' understanding regarding the concept of sines and cosines addition are included in the criteria of very good, it is shown from the average value of 96.87.
- Students' understanding regarding the application of sine to solve the number are included in the criteria of very good, it is shown from the average value of 95.
- Students' understanding regarding the application of cosine to solve the number are included in the criteria of very good, it is shown from the average value of 91.

Overall, the average value of 16 students is 94, meaning that students' understanding on the material of sines and cosines addition are included in the category of VERY GOOD.

When doing the learning procees through worksheets, it was done in groups. The average score of the students' work at worksheets is 90, meaning that students' understanding of worksheets are included in the category of VERY GOOD.

The data about the students' responses on the questionnaire about the learning process of sines and cosines addition through the implementation of mnemonic methods obtained an average score of 3.18. Based on the criteria on the methods of data analysis, it can be concluded that the students' response to the mnemonic method of learning by implementing the addition sines and cosines material are very positive.

CONCLUSION

Based on the test at one high school in Aceh Besar when implementing the method of mnemonic in the material of sines and cosines addition, it was obtained: (1) The students still have difficulties in writing a conclusion on how to remember the formula of sines and cosines addition and thus prefer to communicate the conclusion orally. (2) Students' understanding about the sines and cosines addition at the end of the test showed the score of 94 is under the notation of very good. In addition to that, students' understanding in score groups of 90 are also included into the predicate of very good. (3) From the distributed questionnaires, it showed (3.18) students' responses were very positive towards learning.

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