ENHANCING STUDENTS' COMMUNICATION SKILLS THROUGH TREFFINGER TEACHING MODEL

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Abstract

This research aims to investigate, compare, and describe the achievement and enhancement of students' mathematical communication skills (MCS). It based on the prior mathematical knowledge (PMK) category (high, medium and low) by using Treffinger models (TM) and conventional learning (CL). This research is an experimental study with the population of all students of Mathematics Education Department who took Discrete Mathematics subject matter of one university in the city of Ternate. The results show that (1) the achievement and enhancement of MCS students that used TM are higher than the students learning using CL; (2) Based on the categories of PMK, the achievement and enhancement of MCS of students using TM are also higher than those learning with CL; and (3) There was no interaction effect between learning (TM and CL) and PMK to the achievement and enhancement of MCS of the students.

Keyword: Communication Skills, Prior Mathematical Knowledge, Treffinger Model

Abstrak

Penelitian ini bertujuan untuk menyelidiki, membandingkan, dan mendiskripsikan secara komprehensif tentang pencapaian dan peningkatan kemampuan komunikasi matematis (KKM). Hal ini ditinjau berdasarkan kategori kemampuan awal matematis (KAM) mahasiswa (tinggi, sedang, dan rendah) menggunakan Model Treffinger (MT) dan Pembelajaran Konvvensional (PK). Penelitian ini merupakan penelitian eksperimen dengan populasi seluruh mahasiswa Program Studi Pendidikan Matematika yang mengontrak mata kuliah Matematika Diskrit pada suatu perguruan tinggi di Ternate. Hasil penelitian menunjukkan: (1) Secara keseluruhan, pencapaian dan peningkatan KKM mahasiswa yang mendapatkan pembelajaran MT lebih tinggi daripada mahasiswa yang mendapatkan PK; (2) Berdasarkan kategori KAM, pencapaian dan peningkatan KKM matematis mahasiswa yang mendapatkan pembelajaran MT lebih tinggi daripada mahasiswa yang mendapatkan PK; dan (3) Tidak terdapat pengaruh interaksi antara pembelajaran (MT dan PK) dan KAM terhadap pencapaian dan peningkatan KKM mahasiswa.

Kata Kunci: Kemampuan Komunikasi, Kemampuan Awal Matematis, Model Treffinger

In the field of education, communication skills receive considerable attention. Efforts to improve mathematical communication skills can be done through the learning of mathematics. As a major pillar in the effort to improve the students' communication skills, teachers or lecturers need to innovate introducing new things, ideas, or ways of doing something. According to the National Council of Teachers of Mathematics (NCTM, 2003), the objective of mathematics learning is to develop the ability to: (1) mathematical problem solving, (2) mathematical communication, (3) mathematical reasoning and proof, (4) mathematical connection, and (5) mathematical representation.

Having good communication skill is required to develop reasoning ability, and logical creative thinking.

Mathematical communication skills support other mathematical abilities, such as problem-solving ability. With good communication skills, a problem will be properly represented through mathematical models, tables, graphs, etc. Hulukati (2005) stated that communication skill is a prerequisite for solving mathematical problems. This means that if students are not able to communicate properly and interpret mathematical problems and concepts, he cannot solve the problem well.

Communication covers several aspects. Baroody (1993) said there are five aspects of communication: representing, listening, reading, discussing and writing. Representing found in the NCTM 2003 mathematics curriculum standards is not included in the communication, but becomes one standard that also needs to be developed in the study of mathematics.

Students' listening, reading, discussion and writing abilities need to be trained and improved. These, however, need to be firstly done through examples of how to write a good math. Clark. (2005) suggested that the problem that leads to discussion is one of the strategies to develop mathematical communication. When given a mathematical problem, students are asked to comprehend the problem and work on the solution in small groups. In line with this, Carpenter & Gorg, (2000) state that when students think, respond, discuss, elaborate, write, read, listen, and discover mathematical concepts, they have to do two activities related to communication, namely (1) communicate to learn mathematics and (2) learn mathematical communication. Then, at the time of the group discussion and presentation in front of the class, students express and share their group' ideas to the whole class. With the increase of good communication skills, other skills are also expected to increase.

According to Effendy (2007, p. 10), communication is the process of delivering a message by the communicator to communicant through media that causes effects. Communication is divided into three forms, namely linear communication or one-way communication, relational and interactive communication called "Cybernetics Model. In the first two types of communication, lecturers' role in the learning process is still dominant. In the converging communication, a lecturer acts more as a facilitator and manager. Convergent communication arises when interactive discussion between students and teachers or among students in the class does not go smoothly. In this process, the lecturer sets the class in which the students can solve the problem with minimal help from the lecturer.

The results of the aforementioned studies illustrate that in general mathematics learning process only improves procedural low level thinking ability. In other words, the learning process has not been able to develop mathematical thinking skills to a higher level.

In general, conventional mathematics learning begins with an explanation of the topic, begins with explaining the learning material followed by giving Begins with explaining the learning material followed by showing the students examples and exercises and demonstrating how to answer those exercises. Such learning makes students tend to be passive, thus, gain limited knowledge.

Ratnaningsih (2007) concluded that structured contextual learning is an alternative choice in the learning of mathematics because teachers can improve the students' ability to think critically, creatively, and independently in learning mathematics, involving students' activities optimally, facilitating students to discover and construct knowledge, creating conducive learning, and providing opportunities for students to freely explore.

There are a member of methods used in the teaching and learning mathematics such as problem solving learning. This type of learning is expected to be able to improve communication skills and problem solving abilities. The selected learning model should accommodate the heterogeneous abilities of the students. Students with low and medium ability will have their understanding improved with the help of a proper teaching approach. The selection of the learning model used is, theoretically, to be able to improve mathematical communication skills which in the end could help the students in coping the problems in their everyday life.

Therefore, the lecturers are required to improve the ability of their students. Accordingly, a proper learning model - *Treffinger model* - is required for students to improve their mathematical communication skill. Sofa (2011) stated that the model of learning by Treffinger developed was a development model which process became the main concern. In the first stage of Treffinger model, *basic tools*, students can think divergently without fear of being rejected.   The next stage, *practice with process*, the students are given complex problems that creates cognitive conflict. This will enable students to use their potential to solve the problem. Finally, *working with the real problem*, which involves the students' thinking in a real challenge and encourages them to find out their own solution for the problems given.

Pomalato (2005) concluded that the application of the *Treffinger* model in the process of learning mathematics gives a positive contribution to the development or enhancing of students' creative ability and mathematical problem solving ability. By using Treffinger model, enhancing students' mathematical communication skills can be done systematically that focuses on the process of learning.

METHOD

The method used in this study is a quantitative method to compare the achievement of students and the enhancement of their communication skills. Two groups of students were taught using different approaches. The experimental class was taught using Treffinger model (TM) and control class using conventional learning (CL).

The population in this study was all students of Mathematics Education Department, while the sample was 110 students of Mathematics Education taking the Discrete Mathematics course in Odd Semester Academic Year 2013/2014. In Mathematics Education Department, there were two classes of Discrete Mathematics: Class 5A and Class 5B. Using lottery, class 5A was selected as the experimental class and Class 5B as the control class.

To obtain the necessary data in this study, a test instrument consists of a questionnaire was given to students to measure their PMK and MCS. Results from the test (PMK and MCS) were then statistically analyzed.

The results obtained from PMK test was used to determine the students' ability in both experimental and control classes, also to group the students based on categories of PMK. MCS test was used at the time of pre-test and post-test in order to determine the achievement and enhancing of the students' mathematical communication skills in both classes. The steps used in the analysis of data obtained from the pre-test and post-test are as follows.

1. Calculating the descriptive statistics of the pre- and post-test scores
2. Determining the students' enhancement by find the post-test score of the students
3. Calculating the enhancing by using normalized gain formula:

$$g = \frac{posttest\ score - pretest\ score}{maxsimum\ possible\ score - pretest}$$ (Hake, 1999)

N-gain calculation results were interpreted using the classification of Hake's.

4. Using normality test and homogeneity variance of data distribution
5. Testing the research hypotheses
6. Determining the effect of the TM and CL models and PMK towards students' MCS.

RESULTS AND DISCUSSION

Table 1, illustrates that by PMK category as well as a whole, learning MT given in the experimental class students (n = 54) were able to increase student MCS higher than CL given the control class students (n = 56). By category Hake, MCS increase students are included in the category of moderate (0.3 <g ≤ 0.7) and high (g> 0.7).

Table 1. MCS Scores Between Experimental And Control Classes

PMK	Treffinger Model						Conventional Learning					
	Pre		Post		Gain		*Pre*		Post		Gain	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	S	$\bar{x}$	s
High	33,50	2,69	92,50	3,33	0.89	0.05	33,25	2,37	80,75	2,37	0,71	0.03
Middle	15,91	9,76	69,77	13,90	0,65	0,14	15,76	9,28	46,67	9,92	0,37	0,07
Low	0,91	1,26	38,86	5,63	0,38	0,06	0,77	1,20	31,15	8,08	0,31	0.08
Whole	16,11	12,81	67,69	20,39	0,64	0,19	15,40	12,65	49,15	18,29	0,42	0,16

Tes result of achievement and enhancement scores of MCS of the experimental class and the control class based on PMK categories and overall by using t-test and Mann-Whitney U test with α = 0.05. Base on Mann-Whitney U test of achievement and enhancement scores of MCS was value sig. = 0.00, for PMK high category with t-test sig. = 0.00, for middle category with Mann-Whitney U test sig. = 0.00, and low category with t-test sig. = 0.007. All of value Sig. < 0.05. Thus, the MCS

achievement and enhancement scores of PMK category and overall students taught using Treffinger model was higher than those taught using conventional learning.

To determine the effect of the interaction between learning and PMK on students' MCS achievement and enhancement, two-way ANOVA was used. Prior to using the two-way ANOVA, normality test and homogeneity variance test were applied in the following table.

Table 2. Results of Normality Test on Students' MCS Achievement and Enhancing

	Shapiro-Wilk		
	Statistic	**Df**	**Sig.**
MCS Achievement	0.943	110	0.000
MCS Enhancement	0.927	110	0.000

Table 2, illustrates that result of Normality on students' MCS achievement and enhancing with $\alpha = 0.05$. Base on the Shapiro-Wilk test on the normality, the value obtained the students' MCS achievement was sig. 0.00 and the students' enhancement was Sig. = 0.00, the value obtained was Sig. < 0.05. Thus, the MCS Achievement and Enhancement in both experimental and control classes were not normally distributed. Hence, the data was analyzed by using the interpretation as shown in the figure below.
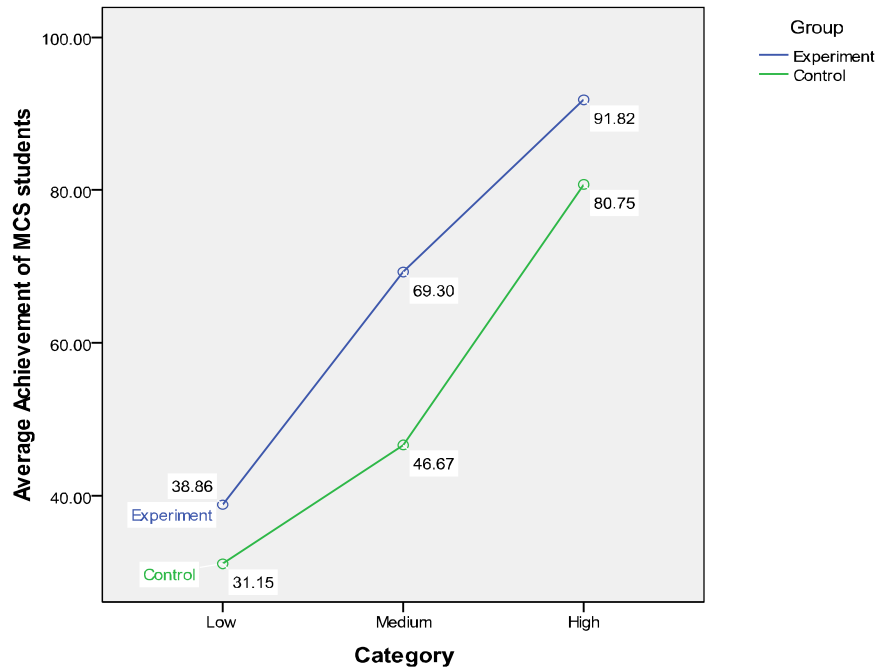

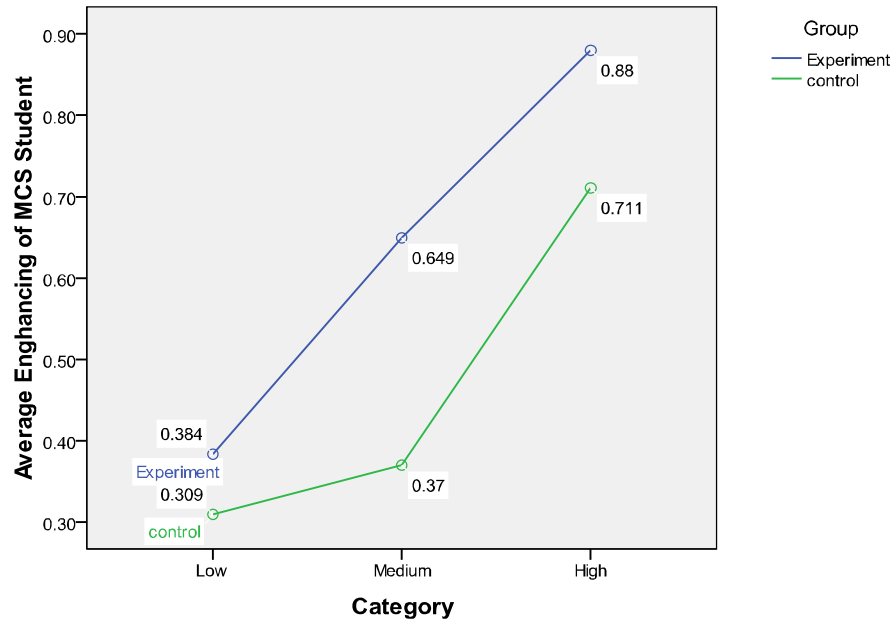**Figure 1. Interaction Between Learning And PMK Towards Students' MCS Achievement**

Figure 2. Interaction Between Learning And PMK Towards Students' MCS Enhancement

Figure 1 and Figure 2 above shows that for all PMK categories (high, medium, and low), students in experimental class had higher MCS achievement and enhancement compare to those in the control class. When the mean of both classes' achievement and enhancement were ranked, the order of the PMK found were high, medium and low.

The similar mean of both classes' achievement and enhancement on their MCS based on PMK category (high, medium and low) indicated that there was no interaction between teaching models and PMK towards students' MCS. The mean difference between the two groups also confirmed the finding of which the high PMK in both groups was almost equal to medium and low PMK.

The results showed that the students' achievement and enhancement on their MCS who were taught using Treffinger model were significantly higher than those taught using conventional model. The effectiveness of Treffinger model supported Pomalato (2005) study that the model not only enhance the students' mathematical ability but also positively contributed to their students' creative mathematical and problem solving ability.

The Treffinger model enabled the students to express their ideas through speaking and/or writing. When working on tasks, students were asked to read and identify mathematical information given and also to write their arguments based on their point of views. The solution from teachers and students were then discussed. Carpenter &Gorg (2000) argue that when students think about, respond to, discuss, elaborate, read, listen to, write or even discover mathematical concepts, at the same time; they were doing two related communication activities: (1) communicating to learn mathematics, and (2) learning mathematical communication. In group discussion or class presentation, students share

their ideas thus their knowledge improved and meaningful. As Piaget (Sanjaya, 2008) stated that a meaningful knowledge is gained from students' self-discovery.

Based on PMK category, the mean of students' MCS achievement and enhancement which have high PMK who get Treffinger model significantly high than the students who teach conventionally. By Hake's category, the enhancing of students' MCS taught using Treffinger model and conventional are high (g>0.7). The students with medium PMK in experiment group has higher mean of MCS than students with medium PMK in control class (0.3<g ≤ 0.7). Students with low PMK in experiment group had higher mean of MCS than students with medium PMK in control group (0.3 < g ≤ 0.7). Each category of PMK, the mean of achievement and enhancement of students' MCS taught with Treffinger model were better than conventional teaching model. It indicates that three category (high, middle and low) Treffinger model is better than conventional.

The results also showed that there was no significant interaction between teaching and learning model (TM and CL), and PMK (high, medium, and low) on students' MCS achievement and enhancement. It was seen in Figure 1 and Figure 2 that there were no changes in the learning pattern for high, medium or low PMK. Hence, it can be claimed that Treffinger model is appropriate for students with low, medium and high ability.

Conventional learning is characterized by the situation in which the teacher explains a concept while students listen to understand the concept to be able to have MCS. A new transferred-knowledge received by the students encourages to the cognitive structure which preceded by cognitive conflict (disequilibrium); furthermore, through the questions from the teacher and students' answers, this conflict can be resolved, so that the structure remains in a state of cognitive balance (equilibrium). Thus, it encourages the development of thinking and understanding of concepts which is required to solve mathematical problems, especially problems related to mathematical communication skills of the students (Prabawanto, 2013).

The example of mathematical problems and exercises given, especially those related to mathematical communication skills can develop students' MCS. However, it might only make them able to copy the procedure exemplified by the lecturer. As a result, the students could easily solve the problems that are similar to the example shown by the lecturer but not with new problems, particularly in relation to mathematical communication skills.

Based on the reliability of the test, all items used in the MCS test were valid, denoted by 0.920 of coefficient of reliability. The level of difficulty of four test items used was categorized as medium which appropriate to test students' MCS, although few students were found to have difficulty in doing the test.

CONCLUSION AND SUGGESTION

Based on the findings, data analysis, and the discussion, it is concluded that either: (1) in overall the achievement and enhancement of the students' communication skills in mathematics

learning by using Treffinger model were higher than those students who were taught by using conventional model; (2) Based on PMK categories (high, medium ,and low) the achievement and enhancement of the students' communication skills in mathematics learning by using Treffinger model were higher than those students who were taught by using conventional model; and (3)There is no interaction effect among Treffinger Model and Conventional model of teaching and the categories of high, medium and low prior mathematical knowledge (PMK) to the enhancement of students' communication skills in mathematics.

This conclusion implies the following: (1) Learning Treffinger model can be applied by the lecturer as an alternative model of learning in order to improve the students' mathematics communication skills in the Universities; (2) Learning Treffinger model can be applied to students with different PMK (high, middle, and low) to serve as an alternative model of learning that can improve the students' mathematics communication skills in University; (3) Learning Treffinger model can be applied to the subject at a lower level, that from elementary to high school in an effort to improve the ability of other mathematically; and (4) For further research, it is advisable to examine other mathematical abilities, both cognitive and affective abilities. This is possible because one of the advantages Treffinger model, which integrate cognitive and affective dimension in its development.

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