Jurnal Teknologi

Full paper

Mathematical Communication Skills of Junior Secondary School Students in Coastal Area

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Article history

Received :11 December 2012
Received in revised form :
30 August 2013
Accepted :15 September 2013

Abstract

Mathematical communication skills of junior secondary school students in coastal area are still considered low due to the lack of contextual problem technique in the teaching of mathematics. The various potencies of the coastal area have been damaged without any concern. It is interesting to investigate the contextual problem in mathematics teaching because it can be identified, required, and related to everyday life. The objective of this study is to enhance mathematical communication skills of junior secondary school students in the coastal area. Using coastal-based contextual teaching and learning (CCTL) can enhance: (1) students' mathematical communication skills better than conventional teaching and learning (CVTL); and (2) the students' learning activity, fluency of argument in problem solving process, advanced question skills, and knowledge of coastal area potencies and problems.

Keywords: Mathematical communication; coastal potency; contextual teaching and learning

1.0 INTRODUCTION

In the National Council of Teachers of Mathematics (NCTM, 2000: 60) it is explained that the communication is an essential part of mathematics and mathematics education. This suggests the importance of communication in the learning of mathematics. Communication enables students to express their ideas to teachers and other students. This communication is one of the five process standards outlined in the NCTM. These five process standards are problem solving, reasoning and proof, communication, connections, and representation (NCTM, 2000: 29). SBC curriculum also emphasizes the students' mathematical communication skills as stated in one of the aims of teaching mathematics at every level of formal education in Indonesia. This means that the enhancement of students' mathematics communicative skill needs attention of every teacher and researcher.

Brenner (1998: 104) suggests that improving students' ability to communicate mathematics is one of the major goals of the mathematics reform movement. The emphasis upon communication in the mathematics reform movement derives from a consensus that learning process most effectively within a social context (Brenner, 1998: 107). Through a social context that is designed in mathematics teaching, students are able to communicate their ideas to solve mathematical problems.

According to Lubienski (2000), the ability of students in communicating mathematical problems is supported by their ability to understand language (Hulukati, 2005: 18). Even Baroody (1993: 2-99) argues that there are two important reasons for focusing mathematics teaching on communication, namely: (1) mathematics is essentially a language; mathematics is more than just a tool for thinking, a means of finding patterns, solving problems, or making inferences, rather mathematics is also an invaluable tool for communicating ideas clearly, precisely, and concisely, and (2) mathematics and mathematics learning are, at heart, social activities; as social activities in mathematics teaching, interactions such as communication between teachers and among students themselves, it is important to enhance the mathematical potential of students. Due to the close relationship between language and mathematics, Cooke and Buchholz (2005: 265) suggest that teachers be able to make a connection between mathematics and language. This connection can help students be able to translate a problem into a mathematical problem, the language of symbols, or mathematical models. This clarifies the close relationship of mathematical communication skills and proficiency.

Indonesia has a wide range of languages and natural resources, especially coastal and cultural resources. Through SBC curriculum, many of the local governments have made local languages the subject of as the local content subject with the aim at preserving local languages used by local communities. This initiative is not anything wrong, but there are still many potentials of the regions, especially those of coastal areas, that have not received sufficient attention from educational institutions. In the coastal areas, where land and ocean meet, live and interact diverse ecosystems allowing easy access for human activity. People such as fishermen, farmers, fish traders, sea product producers, living in coastal regions and small islands are called coastal communities who depend their lives on marine resources and fisheries.

In coastal communities, the use of local languages and culture in everyday communication has become a habit and therefore the preservation of local language is not something urgen. For coastal communities, coastal resource utilization to meet their economic needs is more a priority. Therefore, what they need is guidance and education to better understand and optimally utilize the various potencies provided by the coast for sustainable economy and resource. This can begin from coastal junior secondary school students who are the backbone of the future development of coastal areas. Efforts can be realized in the familiarization of the students with coastal problems solving in contextual teaching and learning mathematics. According to Searsh & Hersh (2001: 4), contextual learning is a teaching that allows students to apply their understanding and academic skills in a variety of contexts both within and outside of school, to solve real world problems or issues that simulated individually or in groups. Orey and Rosa (2006: 17) argues that mathematical applications can be created in a cultural context; social issues can be addressed through the application of mathematics. This opinion shows the importance of a diverse learning contexts.

The results of the preliminary study the writer showed that in coastal areas, the skills students in mathematical problem solving and communications is still poor, particularly in translating problems into mathematical models. This invites intervention to improve students' mathematical communication skills.

This paper aims to reveal coastal junior secondary school students' mathematical communication skills under the CCTL approach. This information can be used as a reference to further develop the CCTL approach, the teaching materials, and aspects that still need improvement of students' mathematical communication skills.

2.0 MATERIALS AND METHODS

This experimental study used two designs, the pretest-post test control group design and factorial design 2 × 2, two school levels (medium and low) and two teaching approaches (CCTL and CVTL).

Samples were draw combining stratified random sampling and cluster random sampling techniques. By means of stratified technique researchers sampled year-8s of the schools under study, they were SMPN 1 Kapontori (medium) and SMPN 1 Batauga (low) of Buton Regency of Southeast Sulawesi Province. The technique is used because of insufficient numbers of classes as well as the number of students in every class in the junior secondary schools in coastal areas. Of the three year-8 class of SMPN 1 Kapontori, two classes were drawn at random, Yaer-8A and Year-8C, as a control class and an experimental class subsequently. Of the five year-8 classes of SMPN 1 Batauga, two classes were drawn at random, Year-8A and Year-8B, as an experimental class and a control class subsequently. Sixty-four students were taught under CCTL approach and fifty-five students were taught under CVTL. The linkage between mathematical communication skills (MCS), learning, and school level is presented in Table 1.

The research instruments used were mathematical communication akills pre-test and posttest, student worksheets, teacher's during-learning observations, and guided interviews with students and teachers to elicit more information about students' difficulties in answering the test that can not be obtained from the answer sheet and teacher's opinion about the use of CCTL approach. Scoring guideline of students' work on MCS test was modified from Maryland Math Communication rubric issued by the Maryland State Department of Education (1991) in the form of holistic scale for grade 8 mathematics. The data used is the data pretest, posttest, dan normalized gain. According to Meltzer (2002: 3), normalized gain (g) was introduced by Hake and is simply the absolute gain divided by the maximum possible gain (ideal):

$$g = \frac{posttest\ score - pretest\ score}{ideal\ \ score - pretest\ score}$$

Interpretation: g-high if $g > 0.7$, g-medium if $0.3 < g \leq 0.7$, and g-low if $g \leq 0.3$ (Hake, 1999: 1). The data were analyzed by means of descriptive-qualitiative analysis, t-test, and two-way ANOVA, employing SPSS-17 program for windows at $\alpha = 0.05$ significance level.

3.0 RESULTS AND DISCUSSION

3.1 Enhancement of Students' MCS Based on Learning Approach

The results of descriptive analysis of the data students' mathematical communication skills (MCS) based on learning approaches are presented in Table 2.

Table 2 shows that students' MCS increased after under CCTL and CVTL. The increase of students' MCS under CCTL is greater than that of students under CVTL. Before the treatment under CCTL approach, the MCS students is 18.047, but after the treatment, increase by 35.6% to 47.266. On the other hand, MCS of students who were taught only under conventional technique increased by 14.4%. Based on Hake's category (1999), the students' MCS under CCTL is in the medium category, while the students' MCS under conventional technique is in low category. The result of significance test of the two different increases in the students' MCS is presented in Table 3.

Table 1 The linkage between the Mathematical communication skills, teaching approach, and school level

		Teaching Approach		
		CCTL	**CVTL**	**Total (T)**
School Level	Medium (M)	MCSM-CCTL	MCSM-CVTL	MCSM-T
	Low (L)	MCSL-CCTL	MCSL-CVTL	MCSL-T
	Total (T)	MCST-CCTL	MCST-CVTL	

Description (example):
MCST–CCTL : Mathematical communication skills of students under CCTL
MCSM-CCTL : Mathematical communication skills of medium school's students taught under CCTL
MCSL- CVTL : Mathematical communication skills of low school's students taught under CVTL
MCSM-T : Mathematical communication skills of medium school's students

Table 2 Description of students' MCS based on learning approach

Learning Approach	Data	N	Score		Mean	Standard Deviation
			Min.	Max.		
CCTL	Pretest	64	0.00	70.00	18.047	14.464
	Posttest	64	20.00	90.00	47.266	13.361
	N-Gain	64	0.13	0.71	0.356	0.131
CVTL	Pretest	55	0.00	70.00	15.909	12.623
	Posttest	55	5.00	70.00	28.455	13.840
	N-Gain	55	-0.08	0.60	0.144	0.138

Remarks: Data in the scale of 0-100

Table 3 Significance test of the difference of increase in students' MCS based on the difference in CVTL and CCTL approaches

Levene's Variance Homogeneity Test		t-test for Mean				
F	Sig.	t	df	Mean Difference	Sig.	Remarks
0.001	0.973	8.533	117	0.211	0.000	Significant

Table 3 shows that the probability values (sig.) from the Levene's test of homogeneity of variance are greater than 0.05, so the variances are homogeneous. So, to test for differences of both mean values, the t-test can be used to show that the probability value (sig.) is smaller than 0.05. This means that students taught under CCTL approach obtain a significantly greater increase in MCS compare to those students taught under CVTL approach. This is understandable because using the coast-contextual problem can students identified so that they were interested and challenged to solve. Kadir (2011: 540-541) argues that when students solve coastal problems, enthusiasm, attention, motivation, and knowledge used to solve the problem with understanding, compare, describe, analyze, create a mathematical model, complete model, answer the problem, discuss the answers, maintaining an answer, and to negotiate the process and the results of solving the problem. Using the real coastal area problem that viscid with everyday life of student has inspired interest of student to solve problem presented. This interest has lead them to make discussion with the teacher and other students to become better understood about the mathematical concept. According to Brenner (1998:108), through their active discussion with teacher and peers, students are expected to gain a greater understanding of the conceptual underpinnings of mathematics and problem-solvers become better.

3.2 Enhancement od Students' MCS According to School Level

The results of descriptive analysis of the data of students' mathematical communication skills according to school level are presented in Table 4.

Table 4 Description of students' MCS data according to school level

School Level	Data	N	Score		Means	Standard Deviation
			Min.	Max.		
Medium	Pretest	51	5.00	70.00	23.726	13.923
	Posttest	51	5.00	90.00	41.177	18.644
	N-Gain	51	-0.08	0.71	0.234	0.192
Low	Pretest	68	0.00	70.00	12.059	11.105
	Posttest	68	5.00	75.00	36.618	14.492
	N-Gain	68	-0.07	0.69	0.276	0.152

Table 5 Significance test of the differences of students' MCS under CCTL and CVTL at each school levels

School Level	Levene's Variances Homogeneity Test		T-test of Means				
	F	Sig.	T	df	Mean Difference	Sig.	H_0
Medium	0.261	0.612	5.490	49	0.236	0.000	Rejected
Low	0.047	0.829	6.881	66	0.195	0.000	Rejected

Table 6 Interactions between the teaching approach and school level in enhancing Students' MCS

Sources	Sum of Square	df	Means of Square	F	Sig.	H_0
School Level	0.066	1	0.066	3.735	0.056	Accepted
Teaching	1.343	1	1.3243	75.713	0.000	Rejected
Interaction	0.012	1	0.012	0.660	0.478	Accepted
Total	11.353	119				

Table 4 shows that both approaches, the CCTL and the conventional. Enhance the MCS of the students at both school levels. In addition, the increase in students' MCS at low-leveled school (27.6%) being greater than the increase of students' MCS at medium-leveled school (23.4%). Based on Hake's category (1999), the increased at both school are in the low category. However, the results of significance using a single t-test show that the enhancement of students' MCS at both school levels is significant.

The results of significance test of the differences between the increase in students' MCS under CCTL and CVTL between the two school levels are presented in Table 5. Table 5 shows that the probabilty value (sig.) at both school levels are less than 0.05, so leading to the conclusion that the two student groups taught under CCTL approach at both school levels enhance significantly greater in MCS than the students taught under conventional technique. However, the results of the significance test of the differences of MCS at both school levels taught under CCTL show no significant difference in the means values. This means that the CCTL approach is able to narrow the differences of students' MCS in the two school levels. The means values indicate that averagely the medium-leveled school students' MCS increase by 0.340 is smaller than increase of students' MCS at the low-leveled school (0.368). Since there is no significant difference between the mean values, the CCTL approach can be applied to improve the students' MCS at the two school levels.

3.3 Interaction between the Teaching Approach and School Levels in Enhancing Students' MCS

The results of the test of the presence or absence of interaction between teaching approaches (CCTL and CVTL) by school level (medium and low) in enhancing students MCS using a two-way ANOVA are presented in Table 6.

Table 6 shows that the probability value for the learning approach is less than 0.05, which means that there is a significant differences of increase in students' MCS in term the teaching approach. Table 6 also shows that the probability values of school level and the interaction with school teaching approach un enhancing students' MCS is greater than 0.05. That is, there is no significant difference of students' MCS enhancement according to school levels and the interaction between the teaching approach and the school level. Figure 1 may further clarifies more clearly the absence of interaction between school-level and the teaching approach in enhancing students' MCS.

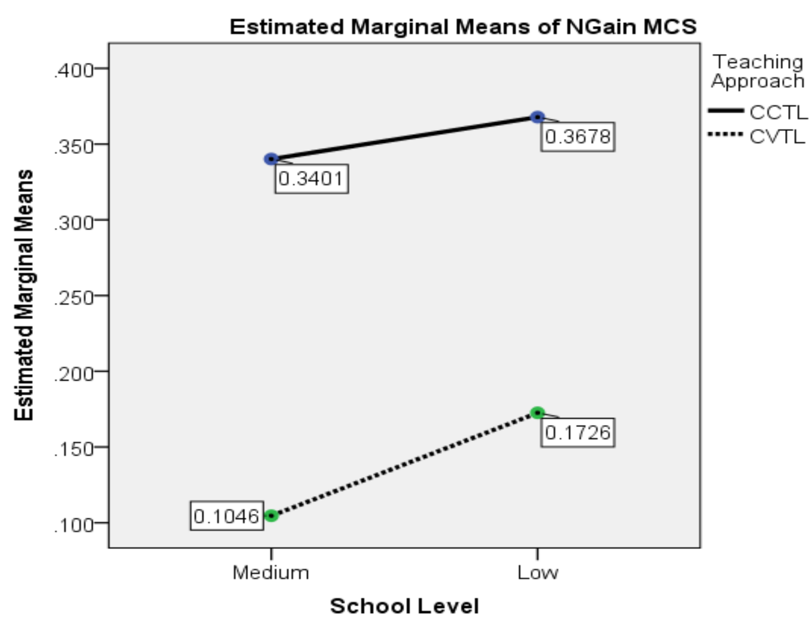

Figure 1 Interaction between teaching approach and school level in enhancing students' Mathematical communication skills

Figure 1 shows that the increase of students' MCS at both school level under CCTL approach is higher than students' MCS under conventional learning. This indicates no difference of students' MCS increase based on the interaction between teaching approach and the school level.

From the difference of MCS, it is also apparent that the difference in MCS increase of students in medium-leveled school taught under CCTL approach and conventional teaching is greater than the one low-leveled school. However, the average increase of students' MCS at low-leveled school is greater than the average increase of students' MCS at medium-leveled school. This suggests that CCTL can be used to enhance students' mathematical communication skills at both school levels.

Students taught under CCTL approach used worksheets in small groups in their learning. According to Goldberg and Larson (2006: 97), discussions in small groups can improve reasoning skills, human relations skills, and communication skills. In such condition, students will learn to share ideas, and to maximize the activity, the teacher must always become the facilitator and the manager who continues to provide guidance so as students are not lost in seeking the mathematical problems solving.

The results of this study are in line with Cooke and Buchholz's (2005: 265) recomendation, that teachers can make a connection between mathematics and language. By means of CCTL approach, teachers train students to understand the relationship between mathematics and language. According to Baroody (1993: 99), one of the reasons for focusing the teaching of mathematics on communication is that mathematics is essentially a language, that is mathematics is more than just a tool for thinking, finding patterns, solving problems, making conclusions, rather, mathematics is also an invaluable tool for communicating ideas clearly, precisely, and concisely. Hughes & Hughes (2003: 322) argues that the best time to teach children is when they feel to need for it. To do realize such learning so that the through processes of students trained, according to Hughes & Hughes (2003: 322-323) can be done by three methods: by arranging that children learn through practical activities that are intrinsically innteresting; by giving them a problem to solve, by presentng them with a challenge; and by selecting subject-matter that appeals to their natural interests. This opinion is in line with the provision of contextual problem on teaching mathematics. Contextual problem to the attention of students and challenge them to solve it by means of mathematical methods or to communicate their mathematical ideas. In the CCTL approach, students were trained to communicate mathematical ideas through pictures, charts, graphs, tables, symbols or mathematical model, problem solving questions, or written questions or explanations, with their own wording, regarding the process and results of a mathematical problem solving.

The findings of this study is also in line with previous studies that the use of cooperative and/or contextual teaching and learning is significantly improved students' mathematical communication skills (Ansari, 2003: viii), mathematical problem solving and communication sklls (Darta, 2004: ix; Hulukati, 2005: viii), critics and creative mathematical thinking (Rantaningsih, 2007: 237-238), and problem solving (Nanang, 2009: 228) and better than the use of conventional learning. The study of Sauian (2004: 6) concluded that contextual teaching base is of relevance and should be adopted where applicable in secondary schools, particularly in the developing world. The consistency of the study results indicate that the use of coast-contextual problems have positive effect to enhance students' mathematical communication skills.

34 Analysis of Students' Score on Mathematical Communication Skills Test

Students's scores on MCS test according to each teaching approaches are presented in Figure 2.

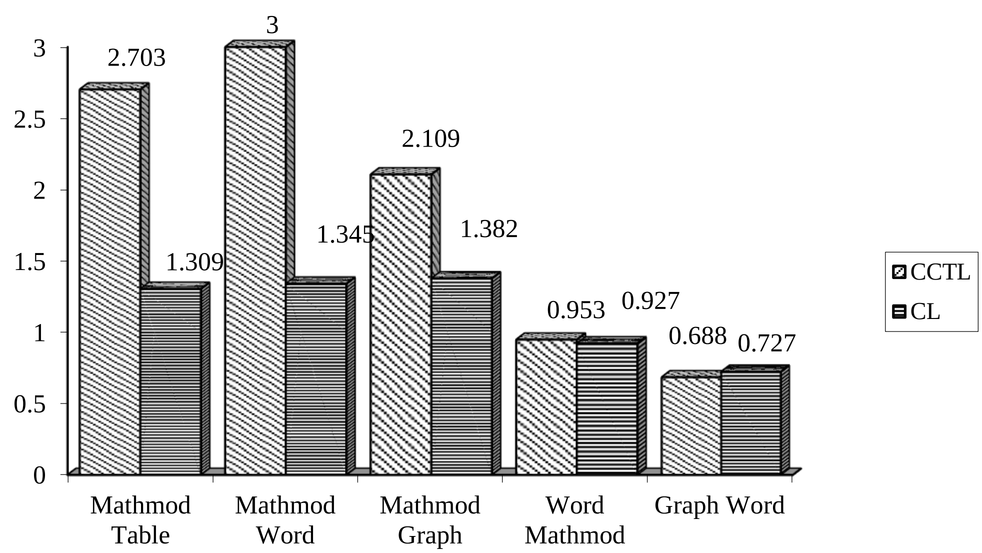

Figure 2 Students' mean scores in every aspect of Mathematical communication skills according to teaching approach (the ideal score is 4)

Figure 2 shows that in every aspect, MCS of the students taught under CCTL is better than the students taught under conventional teaching. The highest MCS aspect of the students taught under CCTL is in making a mathematical model from problem solving questions, while the highest MCS aspect of the Students taught under conventional teaching is in mathematical modeling from problems presented in the form of tables. In both teaching techniques, the lowest MCS aspect is in writing everyday-life-related problem solving questions using mathematical model.

An interpretation of a mathematical symbol is indeed a difficult task for students to do as mathematical symbols are empty of meaning. According to Soedjadi (2007: 8-9), mathematics is very tight in characteristic, especially that it "...

has/uses 'empty' of meaning symbols". Therefore, the concept of a variable misleads teacher's expectations and sometimes hinder students' understanding of algebraic ideas (Leitzel, 1989 cited in Bergeson *et al.*, 2000: 26). According to Baroody (1993: 99), this is due to the fact that teachers and textbooks frequently bring words and symbols with little meaning for children. Baroody further contends that students are rarely asked to explain their ideas in any ways.

In addition to the weakness of students in wording everyday happenings in the form of mathematical models given to them, the results of this study also show that students were less able to graph linear equations in the Cartesian diagram. Interviews with students indicated that the cause was that the students in general have no been able to locate let alone connect the points in the Cartesian diagram. Neither were students able to determine the equation of a line from the existing points. In the Competency-Based curriculum for year-8, the material on drawing graphs of equation of a line should, in fact, be taught and students should master it before learning the material on Two-Variable Linear Systems Equations (TVLSE) in this study. Indeed, the mathematics teacher of the students under the present study stated that the material had been taught, but problem lied in the student's ability. This implies that students' weakness in drawing a graph is a contingent upon their weakness in the previous material. This further strengthens the argument that the students' prior knowledge of mathematics helps determine student success in studying further mathematics materials.

Findings from interviews with students and teachers indicated that several factors caused this: (1) students did not repeat the mathematical material at home, (2) students spent most of the time playing or helping their parents earn a living, (3) the distance from home to school was reasonably long , (4) students' mathematics prior knowledge were low , (5) students' motivation to attend schools was low, (6) students had no books or worksheets as a source of learning at home, whereas the ones at schools were not sufficient, (7) students either had no math notebooks, or had incomplete ones, and (8) students rarely did their homework. However, the teachers admitted seeing an increase in student learning motivation during the study as indicated by the increase of students' attendance frequency, the ability to ask a question or suggest an answer, the speed in analyzing a problem and suggest ways to solve it, and to respond to a problem either individually or in groups.

Teachers and local community leaders saw that the utilization of coastal areas' potentials in mathematics teaching was a good effort. According to them, the utilization of coastal areas in teaching, addition to improve students' learning enthusiasm, enabled students to see the importance of formal education, especially learning mathematics and apply it in daily life. Provision of coastal problem in the worksheet when learning mathematics in groups contributed significantly to the increase in student activities in the process of mathematics learning. Byrnes (2009: 171) argues that the prior context can influence the meaning assigned to a word. It means that the enthusiasm of the students was apparent when students did not feel unfamiliar with coastal problem presented in the worksheet. This is related to the condition and land use in coastal areas which were not under controlled, so that concerns raised in the worksheet drew serious students's attention to the problems presented. According to Ang Keng-Cheng (2009: 181), the experience will be even more if the problem enriching involves issues of public concern. The realization that mathematics has many uses is the effect of the exercise of the student in solving problems presented in the worksheet under CCTL approach. Moreover, students realized that mathematics could be applied to solve some of their everyday life problems, especially, of the coastal communities. However, it was also found that students still faced a lot of problems in solving mathematical communication problems.

4.0 CONCLUSION

Based on the description above, the writer comes to the conclusion that the mathematical communication skills of the coastal junior secondary school students who were taught under CCTL approach significantly improved, and was greater than that of students who were taught under conventional teaching. In addition, the application of the CCTL approach at medium and low-leveled schools has been able to reduce the differences in students' mathematical communication skills at both school level to become insignificant.

Acknowledgement

Thanks to DP2M Higher Education which has provided funding of a grant doctoral research through LPPM Indonesia University of Education in 2009.

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