

Students' Problem Solving Skills in Mathematics with Peer Tutoring Math Pen-Mate

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Abstract: *This study was undertaken to determine the effectiveness of letter writing in fostering the problem solving skills of students. The participants of this study were the Grade 8 students of Pedro "Oloy" N. Roa Sr. High School, Division of Cagayan de Oro City during the school year 2017-2018. Two (2) sections were used as the participants and exposed to Peer Tutoring-Math Pen Mate. One section was considered as the tutor, and the other section as the tutee. One group Pretest-Posttest design was utilized in this research. The instrument used was 15-item teacher made achievement test with a reliability coefficient of 0.79. Data gathered were analyzed using the statistical methods. The mean and the standard deviation were used to describe the participant's achievement level in Grade 8 Mathematics and problem solving skills and the regression analysis was used to determine the effect of Peer Tutoring-Math Pen Mate on students' problem solving skills. Result of the analysis revealed that Peer Tutoring-Math Pen Mate positively influenced students' problem solving skills in mathematics. Based on the conclusion, the researcher recommended that mathematics teachers may utilize Peer Tutoring-Math Pen Mate in the teaching Mathematics and teach mathematics concepts focusing on developing student's problem solving skills. Similar studies may be conducted on the effectiveness of Peer-Tutoring -Math Pen Mate in other content subjects in mathematics and show if integrating technology in the elementary level can also foster their problem solving skills.*

Keywords: peer tutoring, Math Pen-Mate, problem solving skills

1. Introduction

Problem solving is an essential skill to be taught to students. This is one of the skills they will use in real life situations, yet it is one of the hardest to be taught. Because word problem solving as a process is complex than activity, researchers and educators need to give more attention on mathematics instruction which focuses on developing students' problem-solving skills.

The National Council of Teachers in Mathematics (2000), has stressed that the students who are encourage and supported to speak, write, read and listen in mathematics classes has two benefits: they communicate to learn mathematics and the learn to communicate mathematically. Communication becomes a tool in shaping their thinking. The students can explain, justify and analyze their strategies in problem solving.

TIMMS (2007) cited by Tambychik, and Mohd Meerah (2010) that thinking and problem solving skills are divided into three domains; knowledge, application and reasoning. The students must acquire mathematics skills needed especially in problem-solving. Many students are struggling and this is a big problem that needed to be solved. It is important to get the bottom of this problem and find a solution. Programs or innovations could be prepared to assist those students who are struggling with mathematics.

On the other hand, writing activities in mathematics is not normally used in teaching however mathematics teachers integrate writing to understand students more on what they have learned and what they need to know. In Pedro "Oloy" N. Roa Sr. High School, there are students who are still in frustration level in reading and there are some who cannot comprehend. Many of this students struggle in writing. They do not enjoy it and they do not know what to write. All of

these problems became obstacles in teaching problem solving especially that math problems are written in English. In order to solve any math problem, the student must understand first the problem before they can solve it. With this, the teacher must make intervention in such a way that it helps both the students and the teacher.

Researches have shown that peer tutoring is an effective strategy in helping the teacher in teaching students. This strategy creates a friendly environment to help the students' challenges in Mathematics and to give students this opportunity to learn and study through peer tutoring.

In line with this, Peer Tutoring-Math pen mate can also help teachers in reinforcing students' needs. Unlike the usual written assignment, math pen mate provides students an opportunity to communicate mathematically with others. In this way, students can explain, justify and clarify solving problems activities. This intervention do not only relates writing in Mathematics, but also help students communicate mathematically with their pen mate. Hence, their pen mate can help them understand the lesson, share ideas and strategies in solving Mathematical problems.

2. Theoretical Considerations

This study is anchored on the theory of constructivism emphasizing the sociocultural learning theory pioneered by Vygotsky. Constructivism is a learning theory describing the process of knowledge construction (Major and Mangope, 2012). Every child has an ability to imitate which leads to the claims of Vygotsky that every child has a higher level of cognitive development. He claims also that students who engage in a discussion are more likely to improved thinking than to those who work alone (Blanck, 1990). This claim where supported by the Conversational theory of Gordon Pask (1975) where conversation about the lesson is an

important part of learning. Vygotsky (1978) viewed cooperative learning approach as important part of a process which leads to the social construction of knowledge. He suggested that students should talk and interact with each other in that way learning will take place.

Wertsch (1979) clarifies Vygotsky's (1978) claim that there is cognitive development if there is social interaction. The argument rests on the notion that the development of individual cognitive capacities begins when they interact and guide others or "other-regulation" until the student can understand and correct their selves; that is, until they have achieved "self-regulation." To make transition possible from other- to self-regulation is called intersubjectivity as elaborated by Rogoff (1990). For her, this the students who are participants of the activity will discuss the activity. Communication about the activity, both verbal and nonverbal, is the way to reach their goal. Both tutee and tutor look for common idea on which to build a shared definition. Woolfolk (2010) explained the Piaget's and Vygotsky's that the main idea of social interaction is that interaction between the two students motivates them to learn and social interaction causes learning.

In the theory of Dewey (Gregorio, 1976), he stated that learning is an active social process gained through activities and a first-hand experiences in life. The teacher must provide activities that the students will learn better. This is reinforced by the theory of Froebel (cited by Rafols, 2003) which stated that the learner learns only through his own activity.

Macnab&Cummine (1986) as cited by Junsay and Gerada (2014) stressed that the heart of constructivist is the empathy of the teacher for the learners. In peer tutorial, the tutor is also a student hence she/he can understand on how does her/his tutee feels in a certain topic. Hence, the tutors can share their ideas on what they know and how they learn.

This study is also anchored on the socio-constructivist theory learning. In this theory, the learning environment should be created in such a way students can construct their mathematical knowledge through inquiry based activities where students can make conclusion, generalization and communicate. Socio-constructivist theory calls for students to construct their knowledge with the help of other students. This interaction helps to enhance the students to think and learn.

This study aimed to investigate the effectiveness of Peer tutoring-Math pen Mate in fostering problem solving skills in mathematics of Grade 8 students in Pedro "Oloy" N. Roa Sr. High School.

3. Literature Review

A math pen pal program is a written exchange from one school to another school. Phillips, Crespo (1995) conducted a study about math pen pal. They investigated the use of math pen pal letters as a means of increasing the quality of written communication in Mathematics. They elaborated that pen pal

exchange students became more able to communicate mathematically through writing. This letter writing provides the students an opportunity in explaining their answer, asking question, giving and requesting for an advice. Phillips, et al (1995) suggested that through this program students became more able to communicate mathematically through writing According to Smith, Lombardi, Asmi, Hinrichs, Robertson, Buck, and Reid (2017), Phillips and Crespo's study highlights many benefits of pen pal programs. One of which is that it allows students to communicate with other person other than their teachers or classmates which unusual in most academic programs hence this attracts the students. Adams (2010) has noted the importance of communication in Mathematics by saying there would be no Mathematics without a language. Language has a vital role to play in the student ability solve a problem.

Barksdale, Watson, & Park (2007) study demonstrates how pen pal letter writing offers a method to engage the students in recontextualization. The letter exchanges about culture between students from American university and Malawian university were analyzed and the authors saw improvements in the students' writing skills.

On the study of Sajadi, Amiripour, and Rostamy-Malkhalifeh (2013) on representation ability and problem solving ability that relation between two variables, they found out the ability to represent has a direct relation between efficient representation and efficient word problem solving ability. This ability has a factor on the students' ability to solve a problem. With this the teacher must give more emphasis on the student's ability to represent. Bicer, Capraro, and Capraro (2013) noted that one reason that students have difficulties in interpreting is because lack of spatial skills or mathematical imagination.

In this regard, numerous studies (cited by Kuzle, 2013) have reported that improvement in problem-solving abilities is dependent on mathematical knowledge as well as cognitive and metacognitive abilities. Mathematics instruction calls for methods that support students' acquisition and development of these processes. Writing has been acknowledged as one possible method to improve students' problem solving abilities.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2009) stated that students often reflect on the mathematical ideas in the tasks, formulating ideas more likely to be assimilated with their prior knowledge during the problem solving activities. While solving worthwhile problems, students will be actively engaged in all NTCM's process standards: problem-solving, reasoning, communication, connections, and representation (Van de Walle et al., 2009). While the students given an open ended test, we are engaging them in higher order thinking skills.

In the study of Austin, (2008) on the Effects of Peer Tutoring on Fifth-Grade Students' Motivation and Learning in Math, she have found peer tutoring to be a beneficial way to support and improve student motivation with regards to mathematics. It is very practical for classroom teachers to assist students. Students from an environment where teacher-

directed instruction is prevalent are willing to participate and eager to share their thoughts. The teaching focus is taken from the teacher and placed on the student. Collaborative learning allows students to be in charge of their own learning. Students may know to solve problems when the is no story involve but problems are represented in story, solving them can be more challenging for the students because solving word problems requires the use of various cognitive processes in an integrated manner. For children that do not have an adequate knowledge base or low comprehension level, these tasks can be much more challenging (Jitendra, Griffin, Deatline-Buchman &Sczesniak, 2007).

Kourea, Cartledge, &Musti-Rao (2007) and Miller, Topping and Thurston (2010) pointed out the benefits for tutee during peer tutoring and those are effective learning, individual attention, free responding to his companion and friendship his peer. Also Peer tutoring is effective in enhancing their social and behavioral abilities, including communicating, sharing and cooperating with each other in the classroom. The study of Pagon (2013) on the effect on student to student discourse to the students' Mathematics achievement and anxiety, he found out that student to student discourse is an effective method of teaching in improving students' achievement in Mathematics.

There had been many researches that dealt on improving the teaching and learning problem solving skills. Despite the efforts, there are still the students who performed low in problem solving.

This study was inspired by study of Phillips, Crespo (1995) on Math Pen Pal program. This study focused on the use of Math Pen Mate paired with peer tutoring in fostering the students Problems solving and written communication skills. In which, Smith, et. al (2017) highlights many benefits of pen pal programs. Problem solving skills has been the goal of Mathematics and there are many studies which dealt on how to improve the teaching and learning the skills such as Sajadi et. al (2013) and Van de Walle et. al (2009).

4. Methodology

This study used one group pretest-posttest design since it focuses on investigating the effect of Peer Tutoring-Math Pen Mate of the students' problem solving skills. The study was conducted at Pedro "Oloy" N. Roa Sr. High School in P.N. Roa Subdivision, Calaanan, Canitoan, Cagayan de Oro City. It was formerly known as Calaanan National High School and on 2009 it was named after the person who donated the lot Mr. Pedro Oloy" N. Roa Sr. as a sign of gratitude. Pedro "Oloy" N. Roa Sr. High School offers both senior high and junior high. There are 27 junior high sections of which 8 sections are Grade 7, seven sections are Grade 8, six sections are Grade 9 and six sections are Grade 10. For this school year, the time allotted per subject is only 48 minutes. This study involves 2 sections from the Grade 8, one honor class and one heterogeneous class. The Grade 8 level has an average of 45 students.

This study used only one instrument, the teacher made test. This test has 12 multiple choices and 3 open ended tests. The test composed of word problems involving system of linear equation, linear inequalities in two variables and system of linear inequalities. The instrument was evaluated first by the researcher adviser and Mathematics experts for face and content validity. For the validity and reliability test, the questionnaire was administered to the Grade 9 students of Pedro "Oloy" N. Roa Sr. High School since they had taken the subject last 2016-2017. There were 45 items that went through item analysis where 35 items are multiple choice and 10 open ended test. After the item analysis, only 15 items met the criteria of validity where 12 items are multiple choice and 3 items are open ended test. This instrument obtained a reliability coefficient of 0.79.

Statistical tools such as mean and the standard deviation were used to describe the participants' problem solving skills in Grade 8 Mathematics. Linear regression analysis was used to determine the effect of Peer Tutoring-Math Pen Mate on students' problem solving skills.

5. Results and Discussion

Table 1: Mean and Standard Deviation on the level of Students on Problem Solving Skills

Problem Solving Skills	Tutors	Tutees
Mean	26.16	18.07
sd	13.350	8.111
Descriptive Level	AP	D

Legend: **Mean Intervals Description Perfect Score = 48**
 41-48 Advanced (A)
 33-40 Proficient (P)
 24-32 Approaching Proficiency (AP)
 13-23 Developing (D)
 12 and below Beginning (B)

Table 1 shows the pretest and posttest mean score and standard deviation of student's problem solving skills. The mean scores on the problem solving skills of tutors and tutees are 26.16 and 18.07. This means both groups did not reach the 75% standard criterion set by DepEd. However, the tutors' problem solving skills are in approaching proficiency level while the tutees are in developing level. This result supported by the study of Paridjo et al (2017) where the students who has a better mathematical communication skills has also the ability to solve problems.

Table 2: Mean Scores on the level of Students on the 4 Stages of Problem Solving skills

Problem solving skills	Tutors		Tutees	
	Mean scores	Descriptive level	Mean scores	Descriptive level
Understanding the Problem	8.11	P	8.02	P
Devising a Plan	5.93	AP	3.38	D
Carrying out the Plan	5.98	AP	3.18	D
Looking back	6.13	AP	3.49	D

Legend: **Mean Intervals Description Perfect Score = 12**
 11-12 Advanced (A)
 9-10 Proficient (P)
 6-8 Approaching Proficiency (AP)
 4-5 Developing (D)
 3 and below Beginning (B)

Table 2 shows the means scores on the level of the students on the four stages of problem solving skills. In the first stage, the understanding the problem, the tutors and tutees have a mean scores of 8.11 and 8.02, respectively. This means that both groups were in Proficient level. For the second, third and fourth stages, the tutors were in approaching proficiency level while the tutees were still in developing level.

Majority of the students can state what is asked and what are given of a problem. Although there are students who can identify the some information from the problem but cannot completely state all the details. This may be attributed also to the student's capability to comprehend about the problems. Based on their first reading inventory for this school year, there are only 21% of the Grade 8 students who are considered independent readers in this school. There are students who cannot understand the problem unless translated in their dialect.

In the second stage in solving a problem which is devising a plan, in this step the students are required to formulate an equation to be used in the problem. However, most of the students are struggling in devising a plan. In the item number 13, the problem was "Brenda's school is selling tickets to a spring musical. On the first day of ticket sales the school sold 3 senior citizen tickets and 9 child tickets for a total of ₱75. The school took in ₱67 on the second day by selling 8 senior citizen tickets and 5 child tickets. What is the price each of one senior citizen ticket and one child ticket?" Some students may arrive in the correct equations but they made the wrong or incomplete assumption. Both groups struggled in representing the statements into mathematical statement. With this, students cannot solve the problem or end up with the wrong interpretation.

In the third stage, carrying out the plan, most students especially the tutees struggled in performing this stage because they may be able to know what are the steps in solving the problem but because of wrong execution or wrong

In the item number 15, the problem was "the sum of two numbers is 20 and their difference is 4. What are the two numbers?" Some students were able to solve the problem without devising a plan and carrying out the plan. They just used the trial and error method to solve the problem. This means that the students were able to understand the problem but they cannot represent in mathematical statement. This may be attributed to the student's weak foundation in translating statement to mathematical statement.

Table 3: Regression Analysis on the effect of Peer Tutoring-Math Pen Mate of the Tutees and Tutors' Problem Solving Skills

Written Communication Skills	Unstandardized Coefficients		Standardized Coefficients	t	p-value
Tutees	60145	1.054	.664	5.829	.000*
Tutors	8.034	1.091	.747	7.367	.000*

*Significant of 0.05 level

Table 3 shows the summary of the simple linear regression analysis of the Problem Solving skills and Peer Tutoring-Math Pen Mate of the group tutees and tutors. The t- value of the group of tutees is 5.694 with p value is lesser than 0.001 and the t- test of the group of tutors is 7.707 with p value is lesser than 0.001 where both values are lesser than the level of significant 0.05 which implies that we reject the null hypothesis. This implies that the written communication skills of the students can predict the achievement test of the students. This means that the written communication skills are factor in improving the problem solving skills of the students.

In Peer Tutoring-Math Pen Mate, the students are exposed in a discourse and a writing activity. With this activity, the students become aware of their idea on how they understood the problem and they can also be aware of the Pen Mate's idea. The achievement test score and problem solving skills can be predicted by the written communication skills of the students. With this, written communication has a factor in improving students' achievement test score and problem solving skills. This result is supported by the study of Pagon (2013).

6. Conclusions and Recommendations

Based on the findings, the researcher concluded that both groups showed improvement in their achievement test in Grade 8 Mathematics. The achievement test score and problem solving skills of the tutor and tutees are comparable. The Peer Tutoring-Math Pen Mate positively influenced students' achievement test scores and an effective method in improving students' problem solving skills. The researcher then recommends that mathematics teachers may utilized Peer Tutoring-Math Pen Mate in the teaching Mathematics and need to teach mathematics concepts focusing on developing students' problem solving skills. Similar studies may be conducted on the effectiveness of Peer-Tutoring - Math Pen Mate and integrating technology in the elementary level.

References

- [1] Adams, A. (2000). Rehearsal or reorganization two patterns of literacy strategy use in secondary Mathematics class. *The Montana Mathematics Enthusiast*, 7, 371-390. 2000.
- [2] Austin, J. (2008). On the Effects of Peer Tutoring on Fifth-Grade Students' Motivation and Learning in Math. https://digitalcommons.brockport.edu/cgi/viewcontent.cgi?article=1246&context=ehd_theses. January 30, 2018
- [3] Barksdale, M. A., Watson, C., & Park, E. S. (2007). Pen Pal Letter Exchanges: Taking First Steps Toward Developing Cultural Understandings. *The Reading Teacher*, 61 (1). <https://doi.org/10.1598/RT.61.1.6>
- [4] Bicer, A., Capraro R. M. and Capraro, M. M. (2013). Integrating Writing into Mathematics Classroom to Increase Students' Problem Solving Skills. *International Online Journal of Educational Sciences*, 5 (2), 361-369. College of Education, Texas A&M University, USA.
- [5] Blanck, G. (1990). Vygotsky: The man and his cause. In L. Moll (Ed), *Vygotsky and education: Instructional*

- implication and application on sociohistorical perspectives. 31-58. Cambridge. Cambridge University Press.
- [6] Grutas, L. (2014). The Influence of Mathematical Communication on the Students Performance and Anxiety. Mindanao University of Science and Technology. Cagayan de Oro City. Philippines
- [7] Gregorio, H. C. (1976). Principles and methods of Teaching. Quezon City, Philippines. RP Garcia Publishing Company, Inc.
- [8] Jitendra, A. K., Griffin, C. C., Deatline-Buchman, A., & Sczesniak, E. (2007). Mathematical Word Problem Solving in Third-Grade Classrooms. The Journal of Educational Research, 100(5), 283-302, DOI: 10.3200/JOER.100.5.283-302
- [9] Junsay, M. L. and Gerada, E. P. (2014). The effect of reflective journal writing to students' Critical thinking and mathematical Communication skills. http://serp-pids.gov.ph/documents/CPU/CPU_2016-08.pdf. May 5, 2017.
- [10] Kourea, L., Cartledge, G., & Musti-Rao, S. (2007). Improving the reading skills of urban elementary students through total class peer tutoring. Remedial and Special Education, 28(2), 95-107.
- [11] Kuzle, A. (2013). Promoting Writing in Mathematics: Prospective Teachers' Experiences and Perspective on the Process of Writing in doing mathematics as Problem Solving. Center for Educational Policy Studies Journal 3, No. 4, S. 41-59
- [12] Major, T. E. and Mangope, B. (2012). The Constructivist Theory in Mathematics: The Case of Botswana Primary Schools. International Review of Social Sciences and Humanities. http://irssh.com/yahoo_site_admin/assets/docs/15_IRSSH-155-V3N2.202200518.pdf. May 5, 2017
- [13] Miller, D., Topping, K., & Thurston, A. (2010). Peer tutoring in reading: The effects of role and organization on two dimensions of self-esteem. British Journal of Educational Psychology, 80, 417-433.
- [14] Nartani, C.I, Hidayat, R. A., and Sumiyati, Y. (2015). Communication in Mathematics Contextual. International Journal of Innovation and Research in Educational Sciences. Volume 2, Issue 4
- [15] National Council of Teachers of Mathematics. (2000). Assessment Standards for School Mathematics. Reston, VA: NCTM, IN,
- [16] Pagon, R (2013). Student to Student Discourse on Selected Topics in Algebra: It's Effect to Students Achievement and Mathematics and Mathematics Anxiety. Unpublished Thesis. Mindanao University of Science and Technology. Cagayan de Oro City. Philippines
- [17] Paridjo, Waluya, S. W. (2017). Analysis Mathematical Communication Skills Students in the Matter Algebra Based NCTM. Journal of Mathematics. Vol. 13, Pp. 60-66.
- [18] Phillips, E. and Crespo, S. (1995). Math Penpals I Developing Written Communication in Mathematics <https://files.eric.ed.gov/fulltext/ED385439.pdf>
- [19] Polya, G. (1957). How to solve it. Garden City, NY: Doubleday and Co., Inc.
- [20] Rafols, G. (2003). Problem Posing: Its Impact on Problem Solving in Fifth Grade Mathematics. Mindanao Polytechnic State College.
- [21] Rogoff, B. (1990). Apprenticeship in thinking: Cognitive development in social context. New York: Oxford University Press.
- [22] Sajadi, M., Amiripour, P. and Rostamy-Malkhalifeh, M. (2013). The Examining Mathematical Word Problems Solving Ability under Efficient Representation Aspect. <http://www.ispacs.com/journals/metr/2013/metr-00007/article.pdf>. June 14, 2017.
- [23] Siyepu, S. (2013). The zone of proximal development in the learning of mathematics. South African Journal of Education, 33(2): Art. #714, 13 pages.
- [24] Smith, J., Lombardi, M., Asmi, R., Hinrichs, M., Robertson, K., Buck, L. and Reid, A. (2017). Raising Cultural Awareness in Undergraduate Students through an Online Pen Pal Program. <https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=1175&context=utpp>. Nov. 12, 2017.
- [25] Tambychik, T & MohdMeerah, T.S. (2010). Students' Difficulties in Mathematics Problem-Solving: What do they Say?. Procedia - Social and Behavioral Sciences. 8. 142-151. 10.1016/j.sbspro.2010.12.020.
- [26] Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2009). Elementary and middle school mathematics: Teaching developmentally (7th ed.). Boston, MA: Allyn & Bacon/Merill.
- [27] Vygotsky, L. S. (1978.). Mind in Society. London: Harvard Press.
- [28] Wertsch, J. V. (1979). From social interaction to higher psychological processes: A clarification and application of Vygotsky's theory. Human Development, 22, 1-22.
- [29] Wink, J. (2011). Critical pedagogy: Notes from the real world (4th ed.). New Jersey: Pearson Education, Inc. <http://www.mhsl.uab.edu/dt/2012p/hill.pdf>. December 29, 2017
- [30] Woolfolk, A. (2010). Educational Psychology, (11th ed.) Pearson Education, Inc. ISBN 0137144547 li, R. (2010)

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