



Investigating the Effectiveness of Peer Assisted Learning Strategy in Solving Mathematical Word Problems: An Action Research with Grade Six Students

Langa Dorji ^{a*} and Tshering Darjay ^{b*}

^a Tokshingmang Primary School, Tashigang, Bhutan.
^b Yonphula Lower Secondary School, Tashigang, Bhutan.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The purpose of this study was to investigate the effectiveness of peer assisted learning strategy in solving mathematical word problems of grade six in a general classroom. A pre-test and post-test experimental research design was employed involving 8 students in the control group and 8 students in the experimental group respectively. Subject achievement test was administered for both the groups to determine the differences in their learning achievements before the intervention. Peer Assisted Learning strategy (PALS) was used as an instructional strategy. Mathematical word problems solving was taught using PALS in the treatment group while the control group was taught using a conventional method. A t-test for the pre-test revealed that there was no significant mean difference between the two groups, indicating a homogenous learning ability at the beginning ($p=0.802$). However, the post-test analysis revealed a statistical significant difference between the mean scores of experimental group ($M=19.2$) than the control group ($M=10.9$) at $p=.00$, indicating the improvement of students' mathematical word problem solving skills due to the treatment of PALS. Thus, it is commendable that PALS can be used to help develop academic and social skills.

* Ministry of Education;

*Corresponding author: Email: langadorji1991@education.gov.bt;

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1. INTRODUCTION

Mathematics holds a significant position in the contemporary world. It is used worldwide as an indispensable tool in many fields, including natural sciences, engineering, medicine and social sciences. It is taught at all levels of education to strengthen students' mental abilities, teach logical thinking, critical thinking, analytical skills and problem-solving skills [1] lists the five basic building blocks of elementary mathematics as numbers, place value system, whole numbers, fractions and decimals and problem solving [2] breaks math expertise into two components-math content and math maturity. Math content includes the arithmetic, algebraic and geometric procedures and how to use these procedures whereas math maturity includes understanding and solving problems that have not been encountered before, mathematical logic and reasoning, precise mathematical communication, knowing how to learn math, problem posing, transfer of learning, and interest and intrinsic motivation in math. Word problem solving performance is strongly related to text comprehension and arithmetic skills and the word problem solving of difficult items required both text comprehension and arithmetic skills in good measure [3]. Mathematical word problems are a combination of numbers and words in which students apply Mathematics instructions in the context of a problem solving [4]. It is designed to help students apply mathematics concepts to real life situations. Yet, mathematical word problems pose difficulties for many students because of the complexity of the solution process.

Although, Mathematics had always been highlighted as a main and mandatory subject in the schools of Bhutan. Yet, the learning achievement of Bhutanese learners in mathematics is still found low as compared to the rest of the subjects. Many learners had performed below expectations of their grade level on both basic and advanced academic skills, lacked basic communication and analytical skills. On average a learner required one additional year to achieve the same level of competency for that grade [5]. Bhutanese students who have had first-hand experience of learning mathematics in the Bhutanese classroom hold the skepticism that mathematics is either boring or challenging which has even resulted to parents' acceptance and toleration of low performance in mathematics

[6]. The mathematics achievement of class VI students conducted by the National Education Assessment [7], for example, demonstrated students' performance to be "disappointingly low". The majority of the students struggle with the mathematics, in particular with 'word problems'. It was found in Bhutan PISA-D national report that students performed better in items requiring lower cognitive skills, however, there is a significant gap in performance in more demanding task [8]. The problem has become apparent particularly after having known the level of students' interest and word problems solving skills of students in the mathematics classroom. Discussion with critical friend and other colleagues also revealed that students lack mathematical word problems solving skills which hampers in achieving the learning outcomes in mathematics. To address the issue, repetitive and remedial teachings were conducted using the conventional teaching method such as lecture, discussion, questioning and demonstration method. But these methods failed to cater to the diverse needs of the students.

Thus, this action research was conducted with an aim to investigate the effectiveness of Peer Assisted Learning Strategy (PALS) in solving mathematical word problems.

2. OBJECTIVES

1. To study the effectiveness of Peer Assisted Learning Strategy (PALS) in solving mathematical word problems of grade six students.
2. To examine the differences in the mean achievement scores of grade six students in mathematics after the interventions.

3. RECONNAISSANCE

In order to execute this action research, the researchers adopted the steps proposed by [9] which involved situational analysis, competence and literature review. These three components provide an overview of the realities of the situations, competences of the people involved, and link it with the review of literature.

3.1 Situational Analysis

Having served as a Mathematics teacher for more than 19 years at various schools in Bhutan,

the researchers have realized that many Bhutanese students perform relatively low in mathematics owing to the nature and difficulty of the subject. This problem has become more visible after teaching mathematics to grade six students for two consecutive years. Having analyzed their unit test and term examination marks, the researchers found that most of the students have failed to solve mathematical word problems which in turn has impeded learning outcomes in mathematics. Further, the critical friend and other colleagues shared similar concerns, students lacking mathematical word problems solving skills in other grade as well. [10] states that many learners have difficulty solving word problems due to lack of comprehending word problems that come from the semantic structure of the problem and its language consistency with the required operations. [11] pointed out, word problems written in complex language is rated as mathematically more difficult to solve as the same problems written in simpler language. Children's achievement in mathematics is connected to long-term outcomes in both mathematics and literacy [12].

Therefore, the researchers decided to utilize peer assisted learning strategy as an intervention to curb the current issue and to bring improvement in mathematics performance of grade six students.

3.2 Literature Review

3.2.1 Word problem

Several definitions of mathematical word problem can be found in literature. Word problem is any Mathematics exercise where significant background information on the problem is presented as text rather than in mathematical notation [13].

[14] defined word problem as combination of numbers and words in which students apply Mathematics instruction in the context of problem solving. Conversely, [15] defined word problem as problem designed to help students apply Mathematics concepts to real-life situations. As word problems involve a narrative of some sort, they are occasionally also referred to as story problem and may vary in the amount of language used in the question.

[16] noted that one reason that students have difficulties in interpreting is because lack of

spatial skills or mathematical imagination. Further, [17] 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.

[18] 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.

3.2.2 Peer assisted learning strategy

Peer assisted learning is a collaborative approach, in which learners work in pairs or small groups to provide explicit teaching support. It is an organized learning experience in which the learners take on the responsibility for aspects of teaching and for evaluating the success of their peer(s) [19] defines Peer Assisted Learning (PALS) as the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions.

[20] asserts that PALS is method that can improve teaching and learning, provides a safe learning environment to promote learning and retention of knowledge. Students feel more comfortable asking questions to another student and in small or large group discussions, the students themselves have to deliberate and decide different points that are brought to the table.

[19] claims that peer tutoring provides a platform for the students to use their knowledge in a meaningful, social experience. One student serves as the teacher or tutor, and one is the learner or tutee. Peer tutoring can be varied depending on who will be paired and what will be their roles. The peer could be same age, cross age and reciprocal tutoring. Such collaborative teaching practices help us refine one's ideas and better the solutions. It promotes teamwork relieving students isolation in a learning situation. Ultimately, it helps in achieving the learning objective. The diverse needs of students can be better met with peer-mediated instructions that involves students working together on structured tasks.

[21] states that peer assisted learning strategy (PALS) is a version of class wide peer tutoring, where students are paired as 'coaches' and 'players' with role reversal to work together on a particular topic. PALS, is a scientific-based peer-mediated instructional program. Clear instructional activities are planned in advance by the teacher and based on material that has been taught; Procedures and routines for working in pairs are taught by the teacher in advance of peer work; Members of pairs may differ in ability levels (reading, math, or English proficiency). Regardless of the variations in tutoring style, the theoretical framework underlying peer-assisted learning is constructivism, where the tutors take on the role of facilitators to help students process and understand information and construct their own knowledge, rather than the role of information givers who provide knowledge for the students to assimilate [14].

3.3.3 Overarching research question

How Can I Enhance Grade Six Students' Mathematical word problem solving skills through the use of Peer Assisted Learning Strategy?

4. METHODOLOGY

The study employed quantitative research approach involving experimental research design to investigate the effectiveness of peer assisted learning strategy in improving the mathematic achievement of grade six students. The quantitative approach was used to obtained greater knowledge and understanding of the sample population. Further, experimental research design was adopted to study the cause-and-effect relationship between the research variables.

4.1 Sample

A convenience sampling method was adopted in this study. Such non-probability sampling procedure allows the researcher the freedom of choosing the informants based on the similarity of qualities such as background of the participants and quickness to obtain the data [22]. A total of 16 (n=8 experimental, n=8 control group) sixth grade students studying in Tokshingmang Primary School, Tashigang, Bhutan were involved in the study.

4.2 Research Instrument

In this study, two research instruments namely subject achievement tests(pre-test and post-test), and peer assisted learning strategy were

utilized. The test items for the subject achievement were developed by the researchers using the class six mathematics textbook. The test questions consisted of 20 items from various chapters. The subject achievement test (pre-test) was conducted before the treatment to establish the baseline knowledge of the students while the post-test was conducted to evaluate the effectiveness of peer assisted learning strategy. Prior to the commencement of research, the test questions were submitted to the group of mathematics experts for the content validation. The reliability of the instrument was established through a pilot test involving 20 participants who had already learnt the same test contents in their previous grade. The test was found reliable after obtaining internal consistency Cronbach alpha 0.83 for the test items.

4.3 Data Collection Procedures

Approval from the Dzongkhag Education office and the consent from the participants was formally sought before the execution of this research. After the approvals, the study was arranged to take place after the school hours so as to avoid any hindrance to usual academic timings. The subject achievement test was conducted both for experimental and control group during the pre- test in order to draw the baseline knowledge of students. After the pre-test, peer assisted learning strategy was implemented to the experimental group for an hour. The control group was taught same content using a conventional lecture method for the same duration. Both the groups were then administered with the post-test that comprised of same content items with little modifications after the intervention period.

4.4 Data Analysis Technique

The inferential and descriptive data analysis technique was used to present the research findings. The study findings are presented in the form of mean, standard deviation and the t-tests with short descriptions.

4.5 The Intervention: Scaffolding through Application of Peer Assisted Learning Strategies (PALS)

A split list procedure was used to form a reciprocal pair for the experiment group (PALS) based on the assessment data (baseline data) and mathematics score of students in the previous unit. In this procedure, the entire class

was ranked on ability and split in half. The student with the highest marks was paired with the student at the lower end of scale. The pairing was maintained effectively throughout the intervention period. In the pair, one student acted as a coach and the other as a tutor, swapping roles in the middle of the session. The researchers explained to the students how they would solve the word problems in pairs. Students were given a set of instructions that students should follow while working in pairs. They were given a script to focus on while interacting with each other. The researchers prepared this script and the script contained questions and statements that would help the player proceed with the next steps and interactive hints and motivational words to complete each step. The intervention was conducted over 3 months in which students and researchers met 3 times a week.

5. RESULTS

The pre-test and post-test were conducted to both the experimental and the control group with an aim to make a comparative analysis on the students' learning achievement in mathematics before and after the implementation of the Peer Assisted Learning Strategy. A statistical analysis of the mean score of pre-test and post-test for both experimental and control groups were compared using t-tests as presented below.

5.1 Pre-test Results

The t-test analysis for the mean scores of pre-tests for both experimental and control group was examined as shown in Table 1. There was no statistically significant difference in the mean scores of experimental group (M=9.25, SD=2.4) and control group (M=9.11, SD=2.3). The calculated p value 0.802 was found greater than

the significant level .05 ($p > 0.05$). Therefore, it was established that both the groups were homogeneous in solving mathematical word problems prior to the implementation of intervention.

5.2 Post-test Result

The post-test was administered to compare if the use of Peer Assisted Learning Strategy has impact on enhancing students' mathematical word problems skills. Using an alpha level of .05, the independent-samples t-test revealed a statistically significant difference as the obtained p value 0.00 was lesser than significant level 0.5 ($p < .05$) as shown in Table 2. The analysis of the group means for the post-test indicated that the experimental group (M=19.2, SD=3.8) performed significantly higher in the PALS than the control group (M=10.9, SD=2.5). This revealed that use of Peer Assisted Learning Strategy helped in enhancing students' mathematical word problem skills.

6. DISCUSSION

This study was conducted with the aim to investigate the effectiveness of the Peer Assisted Learning Strategy in solving mathematical word problems of grade six students. The pre-test finding revealed that there was no statistically significant difference in the mean score of both experimental (M=9.25, SD=2.4) and control group (M=9.11, SD=2.3). This finding may be associated with the facts that traditional lecture-based teaching with books, chalk and board might have failed to offer interactive participation and didn't help to develop critical thinking, and problem solving skills as compared to cooperative and activity based learning strategies.

Table 1. Comparison of pre-test mean scores of the control and experimental group

Groups	Number	Mean	SD	Sig 2-tailed
Control	14	9.11	2.3	0.802
Experiment	16	9.25	2.4	

Significant at the 0.05

Table 2. Comparison of post-test mean scores of the control and experimental group

Groups	Number	Mean	SD	Sig 2-tailed
Control	14	10.9	2.5	
Experiment	16	19.2	3.8	0.00

Significant at the 0.05

However, the findings of the study disclosed that the mean score of post-test for the experimental group ($M=19.2$, $SD=3.8$) in which students were taught using PALS was comparatively higher than the mean score of the control group ($M=10.9$, $SD=2.5$) that was taught using a conventional lecture method. The difference in the mean score reveals that the use of PALS had a significant influence in enhancing students' mathematical word problem solving skills. Thus, the statistical significant difference between the pre-test and post-test score may be due to the effective intervention and not due to chance. The result of obtaining higher mean score for the experimental group as compared to the control group may be credited to the active roles and participation of the students as required at every stage of PALS. The findings align with [23] who found out that students loved using PALS and found helpful in increasing mathematics skills. PALS also served as a tool to motivate students and inspired to work hard in math. Similar finding was claimed by [20] asserts that PALS helps in improving teaching and learning, provides a safe learning environment to promote learning and retention of knowledge. The result also supports [24] who examined academic outcomes for PAL participants in college algebra and pre-calculus in the 2009, 2010, and 2011 academic years, focusing on the variable of PAL session attendance; reported that the PAL participants earned a higher final course grade that was statistically significant ($p < .05$), [20]. Further, the findings support constructivist learning theory about child-centered learning, social interactions to gain skills such as problem-solving, inquiry, self-determination, critical thinking, learning by discovery and exploration [25]. The data supports to conclusion that PALS enables students to become better learners.

7. CONCLUSION

The importance and effectiveness of PALS cannot be undermined due to its potential performance in enhancing students' learning outcomes as evidenced by the significant differences observed in the mathematical performance of the students who received the PALS intervention in the study. The major finding of study established that there was statistical significant difference in post-test scores of the experimental group compared to the control group. When the teachers are confronted with many challenges such as larger class size and diverse learners, teachers need opt for stimulating teaching strategies like activity based

learning, peer tutoring and cooperative learning strategies so as to keep the learners engaged, motivated and knowledgeable. Peer tutoring strategies like PALS empower teachers to meet math curriculum challenges and support student diversity in the classroom.

8. RECOMMENDATIONS

In the light of the present research findings, following recommendations are proposed;

1. It is imperative for the teachers teaching mathematics to use PALS as an alternative strategy to teach mathematical word problems as it motivates and increases mathematical skills.
2. Peer Assisted Learning Strategy (PALS) may be used in teaching other subjects to observe if the technique brings similar outcomes.

CONSENT AND ETHICAL APPROVAL

The ethical issue has been taken into consideration by the researchers in this study. Written approval was availed from the concerned authority and consents were sought from the participants prior to the conduct of the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wilson SW. Elementary School Mathematics Practices. AASA Journal of Scholarship & Practice. 2009;6(1): 40-9.
2. Moursund D. Computational Thinking & Math Maturity: Improving Math education in K-8 students; 2007. Available:<http://uoregon.edu/moursund/books/Elmath/Elmath.html>
3. Pongsakdi N, Laakkonen E, Laine T, Veermans K, Hannula-Sormunen MM, Lehtinen E. The role of beliefs and motivational variables in enhancing word problem solving. Scand J Educ Res 2019;63(2):179-97.
4. Pfannenstiel K, Bryant B, Bryant D, Porterfield J. Cognitive strategy instruction for teaching word problems to primary-level struggling students. Sage Journals; 2014.

5. Royal Education Council. National school curriculum conference. Rethinking Curriculum. Paro, Bhutan; 2016.
6. Dukpa P. Bhutanese student's attitude towards mathematics: Findings from a cross-sectional survey of grade six students. *Attitude towards Mathematics*. 2015;16(2):37-52
7. Ministry of Education. National Education Assessment in Bhutan: A benchmark study of student achievement in Literacy and numeracy at Class VI. Thimphu, Bhutan; 2003.
8. Bhutan Council for School Examination and Assessment. Launch of Bhutan PISA-D National Report; 2019. Available:<http://www.bcsea.bt/index.php/bhutan-pisa-d-national-report/>
9. Maxwell TW. Action research for Bhutan. *Rabsel the CERD Educational Journal*. 2003;3:1-20.
10. Njagi MW. Language issues on Mathematics achievement. *International Journal of Education and Research*; 2015.
11. Barbu OC, Beal CR. Effects of linguistic complexity and Math difficulty on word problem solving by English learners. *International Journal of Education*. 2010; 2(2):1-19.
12. Ducan GJ, Dowsett CJ. School readiness and later achievement. *Developmental Psychology*. 2007;1428-1446.
13. Boonen A, Schoot Vd, Wesel V, Vries D, Jolles J. What underlies successful word problem solving? A path analysis in sixth grade students. *Contemporary Education Psychology*. 2013;271-279.
14. Bryant DP, Bryant BR, Porterfield JA, Pfannenstiel KH. Cognitive Strategy Instruction for Teaching Word Problems to Primary-Level Struggling Students. *Intervention in School and Clinic*. 2015; 50(5):291-296
15. Lai Y. Effects of mathematical anxiety and mathematical metacognition on word problem solving in children with and without mathematical learning difficulties. *Plus One*; 2015.
16. Bicer A, Capraro RM, Capraro MM. Integrating Writing into Mathematics Classroom to Increase Students' Problem Solving Skills. *International Online Journal of Educational Sciences*. 2013;5(2):361-369
17. Kuzle A. 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*. 2013;3(4):S.41-59.
18. Sajadi M, Amiripour P, Rostamy-Malkhalifeh M. The Examining Mathematical Word Problems Solving Ability under Efficient Representation Aspec; 2013. Available:<http://www.ispacs.com/journals/metr/2013/metr00007/article.pdf>. Retrieved on June 14, 2017.
19. Topping KJ. Trends in Peer Learning. *Educational Psychology*. 2005;631-645.
20. Wessel A. Peer Learning Strategies in the Classroom. *Journal on Best Teaching Practices*. 2015;2(1):14-16.
21. Kroeger SD, Kouche B. Using Peer-Assisted Learning Strategies to Increase Response to Intervention in Inclusive Middle Math Settings. *Teaching Exceptional Children*. 2006;38(5):6-13.
22. Tongco MDC. Purposive Sampling as a Tool for Informant Selection. 2007;5:147-158.
23. Calhoun MB, Fuchs LS. The Effects of Peer-Assisted Learning Strategies and Curriculum-Based Measurement on the Mathematics Performance of Secondary Students with Disabilities. *Remedial Spec Educ*. 2003;24(4):235-45.
24. Lilly M, Goergen K. Peer assisted learning: Consistency goes with success. Unpublished manuscript. SMART Learning Commons, University of Minnesota, Minneapolis, MN; 2011.
25. Vygotsky LS. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press; 1978.

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