# Effectiveness of Peer Assisted Learning Strategies in solving Mathematical Word Problems

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#### **ABSTRACT**

**Background:** The purpose of this study is to test the effectiveness of peer assisted learning strategy, a peer-mediated instructional method in solving mathematical word problems by standard IV students in a general classroom.

**Methodology:** A quasi-experimental study was carried out with a two-group post test design. There were 60 participants from two divisions of a school with 30 each assigned randomly to the treatment group and control groups. The instructional strategy used was Peer Assisted Learning strategy (PALS). Data was collected through a base level test and post-test for both the groups. One tailed 't' test was conducted to determine whether there was any significant difference in the base level scores between the groups and also to determine the effectiveness of PALS.

**Results:** Results of this study indicated the effectiveness of PALS and this reaffirms that collaborative strategies such as peer mediated instructions can be a feasible option in inclusive mainstream schools for improving student performance and engagement.

**Conclusions:** Peer mediated strategies such as PALS can be effectively deployed to develop and promote academic and social skills.

**Keywords:** Peer-mediated instruction, Peer assisted learning strategies, mathematics, word problem solving

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## INTRODUCTION

Mathematics is a universal language, a symbolic language for all cultures and civilizations. Math skills are required in every walk of life throughout a lifespan. The foundation for mathematics is laid in the early years of elementary school [1]. Mathematics is a subject that includes a variety of skills and concepts that are often related and build on one another. Students may master some and may struggle to understand others. Whether one understands mathematics or not, the importance of this subject cannot be denied in one's daily life. The foundation for mathematical performance is innate and there appears to be a natural tendency for humans to build upon this foundation from simple arithmetic to more complex algorithms [2]. Children's quantitative competencies upon entry into school can have lifelong consequences. Children who start behind generally stay behind, and mathematical skills at school completion influence employment prospects and wages in adulthood [3]. At a psychological level, exposure to mathematics helps in developing an analytic mind and assists in better organization of ideas and accurate expression of thoughts. Arithmetic skills and the underlying concepts that constitute mathematics are generally considered part of a basic educational curriculum. Wilson [1] lists the five basic building blocks of elementary mathematics as numbers, place value system, whole numbers, fractions and decimals and problem solving. Moursund [4] breaks math expertise

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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.

Language is an essential cognitive tool of all learning. Proficiency in language or lack of it can influence one's progress to a great extent. The language used in mathematics is slightly different in a mathematical context. The students need a lot of exposure and experience in using language to develop mathematical language. Word problems in mathematics are narratives that provide some background information on the problem in ordinary language than in mathematical notation as defined in the digital source of Wikipedia. Researchers [5] studied whether word problem solving is a form of text comprehension and concluded that text comprehension was a significant indicator of word problem solving and word problem language processing skills and arithmetic skills was a strong indicator of calculation / computation. Word problem solving performance is strongly related to text comprehension and arithmetic skills [6]. The word problem solving of difficult items required both text comprehension and arithmetic skills in good measure.

Students may understand the concepts being taught, and acquire the computational abilities, however to acquire fluency, accuracy and feel confident about their mathematical competency, practicing what is learnt is critical. Lack of immediate practice cannot establish the learning firmly and confidently in the student and therefore more likely to be forgotten. Also, with practice, the students get to know whether they are progressing in the right direction and areas of improvement.

Today's classrooms are increasingly diverse and the teacher has to strive to keep each student engaged, motivated and knowledgeable. There are many inclusive instructional practices available to meet this objective. With inclusive instructional practices gaining importance and an unmanageable pupil teacher ratio in most of the schools in India, teachers are under tremendous pressure to fulfil the completion of this need, the need for students to practice the math skills taught by the teacher. Unfortunately, while some parents take care of this need at home, many do not. Many a times, this critical aspect of mathematical learning may be compromised due to sheer lack of time and support. Teachers need to go beyond their comfort zones, move away from traditional one-way tutoring models to collaborative strategies. Collaboration means the act of working together to achieve something. When we extend collaboration to the teaching-learning environment, we not only refer to collaboration between teachers, but also collaboration between students. Collaboration happens when two or more individuals work together towards achieving a common objective. Collaboration can either happen at teachers' level or the teachers can organize students to work in collaboration. Collaborative strategies are used to make the learners become more active, autonomous and self-responsible. Collaborative learning includes a set of instructional methods in which learners work in small, mixed ability learning groups.

Peer tutoring is a collaborative approach, in which learners work in pairs or small groups to provide explicit teaching support. Peer tutoring 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). 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, reciprocal tutoring and so on [7]. Such collaborative teaching practices help us refine one's ideas and better the solutions. It promotes teamwork relieving student 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. 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) Peers work together approximately for a stipulated time period [8]. Peer tutoring has not only been effective in reading [9-10] but has been found effective in the area of mathematics too both in primary school children as low as in grade 1 and in secondary students [11-12].

#### **METHODOLOGY**

**Research Objective:** To examine whether the use of peer assisted learning strategy (PALS) in solving word problems in addition and subtraction will improve the performance of standard IV students in mathematics.

**Design:** A quasi experimental design study was carried out with a treatment group and control group in a Mumbai suburban school with Standard IV students. There were two divisions of standard IV students who were included in the study. One division was subjected to the treatment and the second division was not subjected to treatment and considered as control group. The students were from different socio-economic background with diverse profile and background, their parents' educational and professional background were varied and none of these intervening variables have been controlled by the investigator. The language proficiency of students for text comprehension was not controlled or measured by the investigator.

**Sample:** Convenience sampling was followed since the school agreed to cooperate with the investigator for this study. The school was located in Mumbai in one of the Western suburbs and followed Maharashtra State Board Curriculum and was privately managed. It was a co-educational school. Sixty students of standard IV were included in the study and were randomly placed in experimental and control group. The students were totally 76; the data pertaining to students who were absent at different levels was eliminated and not considered for the study.

## **Tools:**

**Instructional strategy - Peer assisted Learning Strategies (PALS):** PALS strategy supplements the classroom instructions and is aimed to improve on fluency through guided practice. It monitors for accuracy, provides immediate feedback, helps to take immediate corrective steps and motivates and sustains the engagement level of the students. PALS encourages the students who work in a pair to verbalize / think aloud the steps / process involved with each other before they begin to practice independently. Students are made to work in pairs and such pairs are formed on the basis of their abilities. It envisages a reciprocal one-on-one relationship between students where they play and reverse their roles as coach and player.

The PALS document comprising the manual, PALS script for the word problems, illustration and the scoring sheet was referred to two experts in the field of mathematics for content validation. The documents were modified on the basis of the common suggestions received from the experts.

**Teacher made Achievement Test:** The investigator prepared two sets of tests, the base level test examined all the participants on their computational skills of addition and subtraction and there was no language element involved. The post treatment evaluation on word problems was conducted for students under both the groups after the 4 instructional sessions each on word problems. In addition, there were practice problems that were solved during the session using the appropriate planned strategy.

**Materials used:** The teacher investigator used the black board to a large extent, supplemented with charts displaying the mnemonic 'CUBES', the word map giving the cue words in the class rooms, charts displaying the PALS script for word problems.

## **Data Collection**

Students were paired based on their abilities. The pairing was maintained for all the sessions as much as possible. In the pair, one student acted as a coach and the other as tutee and reversed their roles midway through the session. The peer pairing was done with assistance from the class teacher based on the mathematics scores of the students in the previous unit test and a student with higher grade was paired with a student at the lower end of the scale. The investigator explained to the students how they would be solving the word problems in pairs. The students were briefed with a set of instructions like "Talk only to your

partner, in a low voice and only about the work given. Appreciate your partner when they complete every step. Encourage your partner to complete the work. Both you and your partner should take turns". They were provided a script to focus on during the interaction with each other. The investigator prepared this script and the script had questions and statements that would guide the player to carry on with the next steps and interactive hints and motivating words for completing each step. The teacher and the investigator enacted a role-play as the coach and the player respectively using the script to the class.

#### **RESULTS**

The investigator conducted a total of 8 sessions of 40 minutes. The treatment group was made to solve the problems along with the teacher followed by solving problems with a peer (using PALS strategy). The 30 students in the treatment group were grouped into pairs and given 2 sample problems to practice the interaction. They practiced the problems with one being the coach and the other being the player or tutee in a pair. They reversed their roles and practiced the problems again. The investigator and the teacher moved around in the class and offered help and advice to the students during the practice session. The treatment group had 15 pairs of students working with each other to solve the word problems in addition and subtraction that were given to them. The script to be followed was detailed on two sets of charts and displayed on two sides of the classroom for students to refer. The investigator and the teacher supervised the interaction. The control group solved the problems along with the teacher and was not paired with a peer for problem solving. However, both the groups were given the same amount of total practice time to solve word problems. Both the groups were given independent practice work.

The base level test mean scores of the treatment and control group were 7 and 7.2 respectively. The base level score of the treatment and control groups were subjected to the one tailed 't' test to verify whether there was any significant difference in the mean scores of both the groups. The computed 't' value of base level scores of the treatment and control group obtained was 0.278. The 't' critical value at 0.05 significant level is 1.671. Since the computed value (0.278) is less than the 't' critical value (1.671), there was no significant difference observed in the mean scores of base level scores of the control group and the treatment group. The Post test mean scores of the treatment group and control group were 7.78 and 6.73 respectively. The absolute difference in the mean scores is 1.05 The mean scores of the treatment group and control group were compared using the one tailed 't' test for independent samples and the obtained 't' value was 2.249. The 't' critical value at 0.05 significant level is 1.671. Since the computed value (2.249) is more than the 't' critical value (1.671), there was a significant difference observed in the mean scores of the treatment group and control group. The mean scores of the treatment and control groups show a progressive difference of 1.05, and there was also a statistically significant difference observed between the two scores. This implies that the difference in the strategy used, i.e. PALS strategy made a significant improvement in the scores of students in the treatment group when compared to the mean scores of students who were not supported with PALS. It is pertinent to note that even though there was no significant difference observed in the mean scores of the base level scores between the groups, there was a significant difference observed in the mean scores of the post treatment test between the groups. This implies that the use of PALS strategy was effective.

## **DISCUSSION**

The Pupil Teacher ratio in India is unmanageable in most of the schools and the draft National Education Policy 2019 envisages the ratio to be curtailed below 30:1, meaning 30 or lesser pupils per teacher [13]. The path to achieve this ideal ratio is expected to be strenuous and challenging. One cannot wait until this ratio is achieved and neglect the issues and challenges in the current teaching-learning environment. The students were engrossed in their interaction and worked with such focus and concentration that the pairs completed the problems that were given for practice during the sessions. Group or Partner arrangements are useful for enhancing student engagement [14]. The study shows that use of PALS in an inclusive setup can be effective and can improve the mathematics performance of students. Class wide peer intervention increases the mean achievement of the class [15]. The treatment group of 30 students were paired in such a way that a student who was proficient in mathematics worked with another student who was not as proficient or had difficulties

in mathematics. But both the students in each pair were successful in completing the task, as contrasted in the performance of control group where students who had difficulties in mathematics had incomplete work. Peer assisted learning strategies in mathematical development is effective, feasible and benefits children with and without disabilities [16]. With every session, students who worked in pairs gained more confidence and worked with more speed and accuracy. Students who had earlier struggled in doing mathematics showed more determination to complete with their partner's encouragement and support. Moreover, these students had an opportunity to ask questions using a guideline that helped in improving their own understanding of the problem. Peer assisted learning strategies challenges students' mindset of perceived helplessness in mathematics [7] and is effective for all types of learners [8]. Such class wise peer tutoring promotes social skills amongst students in a natural setting along with academic skills. The students began to look forward to mathematics class where they can work with a peer and the general mood of the class was observed to be cheerful. Peer assisted learning interventions also improve social skills [17]. When students worked in pairs, it was not only beneficial to those students who needed support in solving mathematical problems, but also to those students who guided them. These students displayed patience, determination and extended fullfledged support to their peer(s) until completion of task. Besides academic achievement, it also gave confidence, sense of responsibility, better communication, empathy, understanding and increased selfesteem. Peer learning not only promotes cognitive gains but social and emotional gains too [6]. Teachers should be provided means and resources to keep every child engaged in class by adequately challenging the talented while ensuring participation of all children in classroom. When teachers become mediators, the learning environment changes [18]. Some viable learning strategies that may fit into the new learning environment are collaborative rather than competitive, learner centred rather than teacher centred, and discovery learning rather than expository learning. Cooperative learning, classroom management, motivation programs hold promise than those that deal primarily with curriculum or technology alone [19]. There are certain variables that the investigator did not control or interfere with. Language proficiency of the students, cognitive and motivational factors, socio economic status, parents' education, was not measured and therefore not included as a variable in the study.

## **CONCLUSION**

The relevance and effectiveness of PALS in an inclusive set up cannot be undermined due to its performance enhancing potential, as seen through the significant differences observed in the mathematical performance of the students' who were given PALS intervention in the study. When the teachers are challenged with larger class size and diversity of learner's they need such stimulating strategies to keep the learners engaged, motivated and knowledgeable. The peer tutoring strategies such as PALS allow teachers to tackle the challenges in mathematics curriculum and support student diversity in inclusive classrooms. The importance of Peer assisted or peer tutored programs is such that the draft National Educational Policy 2019 (MHRD, 2019) talks about instituting a National Tutors Program where students will be trained to provide 5 hours of tutoring per week during the school to younger students who need help.

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