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## The effects of self-instructional learning strategy on students' attitude and achievement in mathematics word problems

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### Abstract

*This quantitative study was carried out to determine the effect of self-instructional learning strategy (SILS) on students' attitude and achievement in mathematical word problems. The participants were 125 class IX and X students of Lhuentse Higher Secondary School, Lhuentse Dzongkhag. The data for both baseline and post interventions were collected using survey questionnaires that consisted of three domains: self-confidence, anxiety, and motivation. In addition to the questionnaire, a mathematics achievement test was conducted before and after the intervention. The data were also collected from midterm and annual exams. The intervention was carried out for one month (1st - 30th September). Data were analyzed using descriptive statistics. The results of this study showed that SILS improved students' achievement and attitude towards mathematical word problems. The SILS is an effective approach and we recommend mathematics teachers to incorporate it in their teaching mathematics word problems.*

**Keywords:** Self-instructional learning strategy, Mathematical word problem, Achievement, Attitude.

## **Introduction**

A word problem in mathematics is the “heart of mathematics” (Cankoy & Ozder, 2011, p.92). By solving word problems, students can sense the beauty of using mathematics to address everyday challenges and know how mathematics is connected to their daily life (Akhter et al., 2015). Solving word problems in mathematics is an important aspect of learning mathematics and math thinking. However, even if students can master other math problems, they have a hard time solving mathematics word problems (Vula & Kurshumlia, 2015). According to Burns (2007), word problems represent situations described by words that students should first translate into mathematics language and then present their solutions. It is designed to make students apply mathematics concepts in real-life situations. Zhu’s (2015) study found that students need a high thinking level to solve mathematical word problems. In addition, Daroczy et al. (2015) also classified word problems as the most difficult and complex that students encounter during their mathematical development.

As mathematics teachers, we have experienced that majority of the Bhutanese students struggle with mathematics, especially word problems. Earlier research has also shown that learning mathematics is either boring or challenging for Bhutanese students (Drukpa, 2015). Moreover, according to Bhutan PISA-D national report, students performed poorly in items requiring high cognitive skills, which include mathematics word problems.

Montague (2003) asserts that students with poor math problem-solving abilities lack self-regulation strategies that help successful students understand, analyze, solve, and evaluate complex cognitive problems. Thus, this action research was carried out to study the effectiveness of self-instructional learning strategy (SILS) on students’ achievement and attitude towards mathematics word problems.

## **Literature Review**

Self-regulated learning is defined as “self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals” (Zimmerman, 2001, p. 14). Self-regulation strategies are necessary to gain access, monitor, and regulate one’s cognitive functions. In addition, Montague (2008) noted that self-regulation strategies like self-instruction, self-questioning, self-evaluation, self-monitoring, and self-reinforcement, help learners in gaining access to cognitive processes that facilitate learning, guide learners as they apply the processes within and across domains, and regulate their application and overall performance task.

Montague (2003) asserts that students who are poor mathematical problem solvers lack metacognitive or self-regulation strategies that help successful students understand, analyze, solve, and evaluate complex cognitive problems.

Self-Instructional Learning Strategy (SILS) is a self-regulation strategy that students can use to manage themselves as learners and direct their own behavior while learning (Montague, 2007). It is a strategy by which students self-tutor and self-monitor. This is quite different from the conventional teacher-dominated strategy of teaching, where the teacher dishes out learning content and the learner merely struggles to learn them. In the conventional strategy, the teacher directs the activities of learning, but self-instruction is learner-directed. Here, the student takes charge of the learning activity, while the teacher merely guides. Learners are responsible for their learning. Moreover, Gitome et al. (2013) claim that the student who is self-instructed is well disciplined which will lead to improved academic performance. For instance, students' indiscipline is one of the main causes of poor examination results in secondary schools. We have observed that the students who lack discipline has low motivation to learn and they fail to concentrate in class.

Montague et al. (2011) did a study to examine the effect of Montague's Cognitive-Metacognitive instructional strategy in solving mathematical word problems for middle school students with learning difficulties. They found that this strategy improved students' word problem solving ability. Anyichie and Onyedike (2012) also carried out a study to investigate the effects of SILS on senior secondary students' achievement in solving mathematical word problems. The study utilized a nonrandom control group pretest-posttest experimental design and found that the students in the experimental group performed significantly better than those in the control group. In addition, after investigating the effect of teaching the cognitive and meta-cognitive self-instructional strategy on verbal math-problem solving performance of students with verbal problem-solving difficulties, Narges (2015) concluded that teaching the cognitive and meta-cognitive strategies lead to significant improvement in students' ability to solve mathematics word problems.

The study conducted by Adani et al. (2012) found that SILS was effective in improving the achievement in algebra of students with learning difficulty in mathematics. For instance, they found that the mean achievement scores of students with learning difficulty in mathematics who used SILS to learn algebra were significantly higher than those who used conventional method. Moreover, Vula et al. (2017) found that by using SILS, students were able to control their action, to reason, and to reflect, which influences their success in solving a math word problem. Therefore, it can be concluded that the use of SILS enhances students' learning and achievement in mathematics.

SILS was also found effective in learning other subjects. For example, Kan'an and Osman (2015) found that SILS improved students' learning readiness and achievement in science. Similarly, Ikwumelu and Oyibe (2014) studied the effects of SILS on secondary school achievement in social studies. Their study revealed that students who learned social studies using SILS performed better than the students who were taught social studies with conventional instructional methods. In addition, Peldon (2021) claimed that there was strong relationship between metacognitive self-regulated geography learning and achievement in Bhutan geography of grade eight students in one of the school in Thimphu. Therefore, it can be concluded that SILS is effective in learning most of subjects.

Apart from achievement in mathematics, attitude is also a major focus in SILS. According to Adelson and McCoach (2011) attitude towards mathematics is self-perception as a mathematics learner and their ability to learn mathematics. A study conducted by Ifamuyiwa and Akinsola (2008) found that a SILS improved students' attitude towards mathematics. Similarly, Ozsoy et al. (2009), found that after using SILS students showed a positive attitude towards mathematics.

According to Hiller et al. (2021) there was a significant relationship of mathematics anxiety and mathematics self-efficacy with mathematics performance. However, Johnson et al. (2021) claimed that the self-regulation strategies were effective in helping students to regulate their anxiety. Dorji et al. (2021) claimed that students' attitude towards subject is one of the factor responsible for the students' poor achievement in mathematics in Bhutanese secondary level school. One way to improve students' attitude towards mathematics is by allowing students to use SILS. While SILS was found effective elsewhere in learning mathematics word problem, there was no evidence of its effectiveness in learning mathematics word problem in Bhutanese schools. Therefore, we want to investigate the effect of SILS on students' attitude and achievement in mathematics word problem.

There are some researched-based instructional models which can assist students to instruct themselves while solving mathematical word problems. They include, among others, STAR Cognitive Strategy (Search, Transform, Answer and Review), Polya's four step process strategy, and Montague's cognitive-metacognitive instructional model. For this study, however, Montague's cognitive-metacognitive instructional model, which was designed for solving mathematical word problems was implemented as an intervention strategy as it comprised many learning skills and strategies. Montague's instructional model consists of seven step cognitive processes: Read, Paraphrase, Visualize, Hypothesize, Estimate, Compute, and Check (See Appendix A).

## **Context**

Lhuentse Higher Secondary School (LHSS) is in Lhuentse Dzongkhag. It was established in 2004. The school has 498 students (216 boys and 282 girls) studying from class VII - XII. Most of the students come from diverse socio-economic and parental educational backgrounds. The school has 31 teachers (25 males and 6 females).

According to Lhuentse Dzongkhag Students' Academic Result Analysis Report of 2021, class IX and X students of LHSS performed disappointingly low in mathematics in the Midterm examination. The mathematics mean scores for class IX and X were 33.3 and 29.3 respectively. Specifically, most of the students scored less than 40% of the total score in mathematics word problems. Therefore, we realized that the way we teach mathematics word problems required immediate attention. With the intention to find ways to improve students' ability to solve mathematics word problem we chose our own class IX and X students to carry out this action research. Both of us are teaching mathematics from class IX to XII for more than eight years and are trained in conducting action research.

## **Research Question**

Based on the literature and situational analysis, we posed the following question as our action research question:

Will the students' attitude and performance in mathematics word problems improve if teachers employ a self-instructional learning strategy?

## **Intervention Strategies**

The following intervention strategies were used in the teaching and learning of mathematics word problems. The intervention was carried out for one month (1st - 30th September).

## **Real-life Application in Word Problem**

According to Farren (2008), students find mathematics boring, difficult, and hard to relate to due to absence of real-life application in instruction. Moreover, students show greater appreciation for the content if the teacher connects math concepts to real-life situations (Gallenstien, 2005). In the first week of the intervention period, the teachers explained the importance of mathematics word problems in real-life situations. Teachers also explained how word problems help students in developing higher order thinking skills.

## **Self-instructional Learning Strategy**

This AR used Montague's Self-instructional model. It had seven steps: Read, Paraphrase, Visualize, Hypothesize, Estimate, Compute, and Check. In the first week of the intervention phase, we created awareness on the concept and importance of self-instructional learning strategy in solving mathematical word problems. After explaining seven steps of Montague's Self-instructional model, the students were trained on solving mathematical word problems using the model. For the remaining three weeks, students were made to solve mathematics word problems using SILS. We gave oral and descriptive feedback as it gives information about the gap between the current level of understanding of learning task and the expected learning outcomes (Hattie & Timperly, 2007).

## **Methodology**

This action research used a quantitative research approach to examine the effect of SILS on students' attitude and achievement in mathematical word problems. The baseline data for the study was collected through pre-survey questionnaires (N=122) from all class nine and ten students except for three students who were absent that day and a class test in the second week of August, 2021. After the baseline data collection, intervention strategies were administered to students for one month starting from September. Post-intervention data were collected in October through post-survey questionnaires (N=124) and a class test. One student was absent when a post survey was conducted.

### **Research Instruments and Data Collection Procedures**

The study employed three tools to collect both baseline and post intervention data as detailed below.

### **Attitude Questionnaire:**

To ensure reliable results of this study, a 5-points Likert scale questionnaire was developed and administered to investigate students' attitude toward mathematical word problems (Appendix B). The questionnaires consisted of four items to measure self-confidence, three items for anxiety, and three items for confidence. The responses in the questionnaires were gathered both during baseline data collection and post-intervention. Validity is an important feature for an instrument. An instrument is said to have high validity if the degree of its ability to measure what it should be measured is high (Wiersma, 2000). The value for Cronbach's Alpha for self-confidence, anxiety and confidence surveys was  $\alpha=0.71$ ,  $\alpha=0.78$  and  $\alpha=0.84$  respectively.

### **Achievement Test:**

In this study, the achievement test was used to measure the students' ability to solve mathematical word problems. Different sets of questions were used for class IX and X. The posttest items were different from the pretest items but had the same levels of thinking (Appendix C). The time allocated was 45 minutes for both the tests. All the items used were based on the New Normal School Mathematics Curriculum Framework (2021) implemented during COVID-19 pandemic.

**Mid-term and Annual-Exam marks:** Students' marks obtained in mathematics questions related to word problem were used as a third data source.

### **Data Analysis**

The data obtained from the students' survey questionnaire and achievement test were analyzed using descriptive statistics. A paired-sample t-test was carried out to determine the statistical significance of SILS on attitude and achievement of students in mathematics word problems.

### **Results**

The effect of SILS on students' attitude and achievement in mathematics word problems are described below.

#### **Effect of SILS on Students' Attitude Towards Mathematical Word Problems**

Attitude of students towards mathematics word problems was garnered through survey questionnaires in three areas namely: self-confidence, anxiety, and motivation as detailed below.

#### **Self-confidence**

Table 1 shows pre and post percentage responses to the self-confidence category towards solving mathematics word problems. Statement 2 showed an increase of 14.2% in the number of students understanding most difficult mathematical word problems. Statement 4 showed 13.4% more students having less trouble learning mathematics word problems. It was found that students became more confident to solve word problems after intervention.

**Table 1** *Pre and Post self-confidence score of Students toward Word Problems*

Statements	Pre-Survey (%)	Post-Survey (%)
I usually do well in mathematics word problems	28.6	37.8
In my mathematics class, I understand even the most difficult word problems	15.6	29.8
Mathematics word problems are more difficult for me than for many of my classmates	32	29
I have less trouble learning mathematics word problems than other mathematics problem	18.8	32.2
Average	23.8	32.2

### **Anxiety**

Similarly, the data showed that students' anxiety related to mathematics problems decreased in the post-intervention data. For instance, Table 1b indicates that there was a 2.6% decrease in the percentage of students getting nervous when solving mathematics word problems. In addition, statement 6 (I worry that I will get low marks in mathematics word problems) and statement 7 (Mathematics word problems make me feel restless and irritable) showed a decline in the percentage of students strongly agreeing and agreeing. It clearly showed that students became less anxious after the intervention strategy.

**Table 1** *Pre and Post anxiety score of Students towards Word Problems*

Statements	Pre-Survey (%)	Post-Survey (%)
I get very nervous when I have to do mathematics word problems	36.2	33.6
I worry that I will get low marks in mathematics word problems	69	64.2
Mathematics word problems make me feel restless and irritable	28.6	27
Average	44.6	41.6



**Motivation**

Additionally, the students’ motivation in solving word problems also enhanced as evident from an average increase of 2.8% in their motivation level. For example, Table 1c shows after a SILS 2.4% more students enjoyed doing mathematics word problems. Similarly, students looking forward to solving mathematics word problems increased by 2.8% (Statement 9). Further, statement 10 showed that 3.2% more students viewed the challenge of solving mathematics word problems as appealing.

**Table 1** Pre and Post motivation score of Students towards Mathematics Word Problems

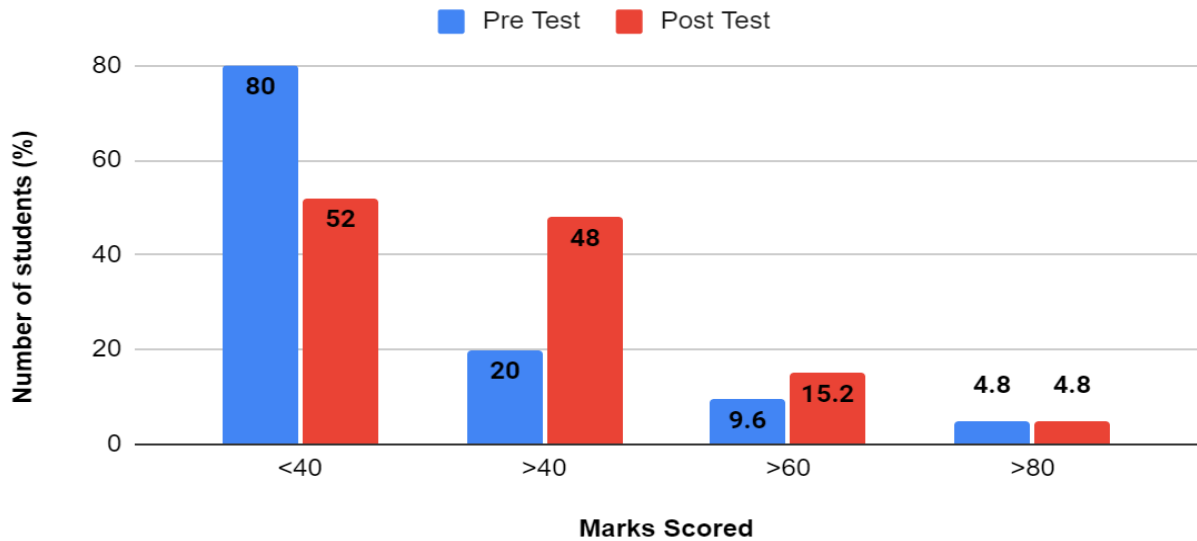
Statements	Pre-Survey (%)	Post-Survey (%)
I do mathematics word problems because I enjoy it	55	57.4
I look forward to solve mathematics word problems	69	71.8
The challenge of mathematics word problems appeals to me	50	53.2
Average	58	60.8

**Effects of SILS on Students’ Academic Achievement in Mathematical Word Problems**

To determine the effect of SILS on students’ achievement, an analysis of mean and standard deviation of pre and posttest marks was carried out. The data revealed that the students’ performance in mathematics word problem improved significantly after intervention. For instance, the average score for pretest was 27.06 with a standard deviation of 20.55 and that of posttest was 38.64 with a standard deviation of 20.15. The mean achievement gain of 11 (approximately 43%) is significance with  $t(124)=-5.238$  and  $p < 0.05$ . Therefore, this finding implies that students’ achievement improved as a result of the intervention.

The analysis of students’ scores in the mathematics word problems from pre and posttest too revealed that the students’ performance in mathematics word problems improved noticeably after the intervention as reflected in Figure 1. For instance, the students’ score in the mathematics word problems in the pretest indicate that a majority of the students (80%) scored less than 40 marks, 20% of them scored above 40%, 10% scored above 60% and a meagre 5% scored in the 80s. However, in the posttest, the number of students who scored > 40 marks increased by 28% and for >60 increased by

5.6% in the posttest. Further, the pass percentage increased from 20% (Pretest) to 48% (Posttest).



**Figure 1.** Comparison of Learning Outcomes of Student's Performance in Word Problems from Pre and Post-tests

Further, the students' performance in the mathematics question related to word problems in the annual exam improved compared to midterm exam. For instance, the mean of midterm and annual exams were 6.6 and 12.06 respectively. It showed that the mean increased in the annual exam by 5.46 marks is significant with  $t(124)=-3.989$  and  $p < 0.05$ . This finding confirmed the effectiveness of SILS to solve mathematical word problems

## Discussion

The study was carried out to improve students' attitude and achievement in mathematics word problems through SILS. From the analysis of attitude survey results, it was found that most of the students had high self-confidence and motivation and low anxiety towards mathematics word problems due to SILS. These findings are consistent with the earlier studies (Ariyati & Royanto, 2018; Mokoena, 2012; Ifamuyiwa & Akinsola, 2008) which found a positive significant relationship between attitudes toward mathematics word problems and metacognitive strategies.

The comparative analysis of mean and standard deviation of posttest with that of pretest revealed significant improvement in students' ability to solve mathematics word problems after using SILS. The finding of this study is in agreement with previous findings of Anyichie and Onyedike (2012) which demonstrated the effectiveness of SILS on

secondary school students' academic achievement in solving mathematical word problems. Furthermore, Montague et al. (2011) examined the effect of Cognitive–Metacognitive instructional strategy on solving mathematical word problems for middle school students. The findings were positive and support the efficacy of the intervention strategy when implemented by mathematics teachers. In addition, Maccini & Hughes (2000) found that SILS improved students' ability to solve mathematics word problems. The reason for significant improvement in students' attitude and achievement in mathematics word problem as a result of SILS is it actively engages students in learning task and it supports and facilitates the internal process of learning (Zimmerman, 2001). In our past experiences, we have found that most of students have difficulty in understanding and solving mathematics word problem. Moreover, they also believe that mathematics word problem can be solved by only intelligent students. This action research has been good experience for us to bring changes into our own practices that will have significant effect. At the end of the intervention we found that students became more confident and enjoyed solving word problems.

### **Conclusion and Recommendation**

This action research examined the effects of SILS on students' mathematical achievement and attitude towards mathematical word problems. The data gathered from baseline and post intervention were analyzed using descriptive statistics. A paired-sample t-test was also carried out to determine the statistical significance. The results revealed that SILS improved academic achievement in mathematics word problems, and it had a positive effect on the formation of a more positive attitude towards mathematics word problems among students. SILS increased the student's problem solving skills leading to improvement on academic achievement in mathematical word problems. Having seen the effect of self-instructional strategy on solving mathematical word problems, it becomes imperative for teachers to model and use self-instructional strategies during instruction. They should, therefore, focus not just on the contents of subjects but also assist students to monitor their learning process. Moreover, students can use SILS to learn mathematics word problem as it provides them with element of control over their learning.

### **Limitations**

The findings of this AR are limited to only class IX and X students of the focus school. Generalizing the findings to the rest of the students in the schools of Bhutan might not be appropriate. In the future, the study could be conducted to study the effect of self-instructional learning strategy on strands of other subjects to expand the findings and its generalizability.

## **Competing interests**

No competing interest exist

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