



## Enhancement of Class X Student's Achievement in Mathematics Through Implementation of Think Aloud Pair Problem Solving Strategy (TAPPSS) as a Revision Tool in the Mathematics Classroom

**Raffic Mohammad**

Ministry of Education, Wanakha Higher Secondary School Paro, Bhutan

\* Corresponding Author: **Raffic Mohammad**

---

---

### Article Info

**ISSN (online):** 2582-7138

**Impact Factor:** 5.307 (SJIF)

**Volume:** 04

**Issue:** 06

**November-December** 2023

**Received:** 23-08-2023;

**Accepted:** 26-09-2023

**Page No:** 237-243

### Abstract

This action research aimed to investigate the effectiveness of Think aloud pair problem solving strategy (TAPPSS) in enhancing the academic performance of class X students in mathematics. The TAPPSS strategy was implemented as a revision tool to assess its influence on academic achievement. This action research was conducted among two sections of grade X students at Druklingthang Central School in 2021. The treatment group (N=20) received the TAPPS strategy during the revision process, while the control group (N=20) followed the conventional revision approach. Following a two-month intervention period, a post-test was administered to both the control group (N=20) and treatment group (N=20) using the prepared set of questions. To assess any improvement in mathematics achievement, eight Likert scale questions were developed for the data triangulation and were administered. To validate the study, quantitative analysis was performed on pre-test and post-test results of both experimental and control groups using the paired sample t-test, and individual sample t-test, and ANOVA test. The results indicated that the intervention strategy (TAPPSS) had a significant impact on the students' mathematics achievement. Exploring the effectiveness of the TAPPS method in evaluating problem-solving behavior and achievement presents an intriguing avenue for the future research. This study could also focus on both mixed-ability pairs encompassing a high-performing student and a low-performing student, and high ability pairs composed of high achievers.

**DOI:** <https://doi.org/10.54660/IJMRGE.2023.4.6.237-243>

**Keywords:** TAPPSS, revision tool, Mathematics achievement, conceptual knowledge

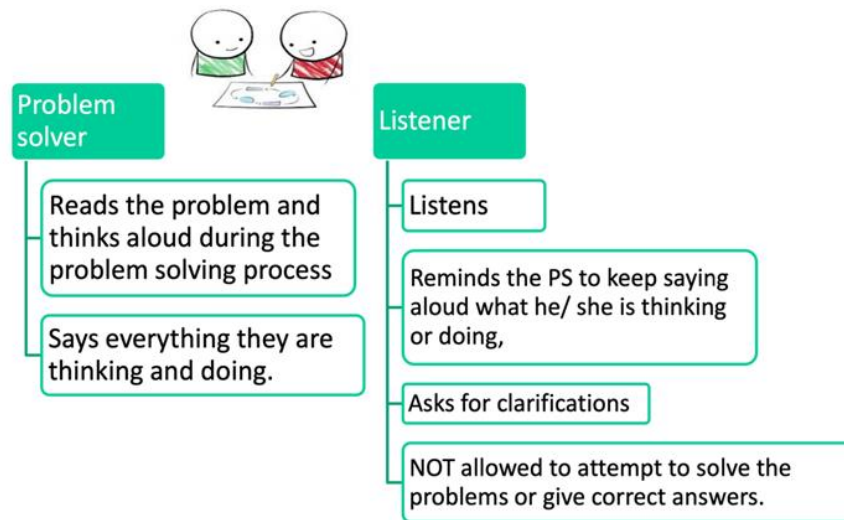
---

---

### Introduction

The motivation behind conducting this action research was the consistently low performance of the students in mathematics at Druklingthang Central School, which was observed to be lower than their performance in other subjects. The average marks for the mathematics in 2018 and 2019 were 56.5% and 44.83.83% respectively, compared to the national averages of 56.83% and 52.02% during the same period. Moreover, the performance of class X students in mathematics was 38.71% without continuous assessment in 2018, 37.83% without continuous assessment in 2019, and 41.45% without continuous assessment in 2019, which represented the lowest average among all subjects in most academic years. These findings highlight the urgent need for research and interventions aimed at addressing the persistent underperformance in mathematics at Druklingthang Central School.

Problem-solving in mathematics involves complex mental processes such as visualization, imagination, abstraction, and information association. By engaging in problem-solving, students can enhance their abilities in application, analysis, synthesis, and evaluation (Anderson & Krathwohl, 2001) <sup>[1]</sup>. Verbalizing their knowledge during problem-solving helps students reflect, clarify, and focus on solving step by step. "Thinking aloud" requires students to express problem specifics, decisions, and reasoning, benefiting struggling students by facilitating a deeper understanding before attempting solutions. Thinking aloud pair problem-solving, based on thinking aloud and listening, is a method advocated by Joen *et al.* (2005).



**Fig 1:** Conceptual framework of think aloud pair problem solving strategy (adapted from “*Problem solving and comprehension*” by Whimbey, A., & Lochhead, J. (1986) <sup>[11]</sup>)

The problem solver reads the problem and says everything he/she thinks while solving the problem. On the other hand, the listener actively listens and asks for clarifications if any, however he/she is not allowed to solve or give hint of the answer as shown in Figure 1.

This action research intends to bring improvement in the problem-solving skills of the students in mathematics. It also aims to develop the comprehension skills. Therefore, the main target of this AR is to bring improvement in academic performance of the students.

This action research was carried on two sections of grade X students of Druklingthang central School in the year 2020. Students who participated in this study were assigned a listening partner and verbalized their thought processes. It was intended to improve their academic performance.

## Reconnaissance

### Situational analysis

Schools in Bhutan have two examinations for grade X before Board examination, mid-term examination and trial examination. Trial examination precisely is a form of preparatory exam for Board examination. Trial examination takes place approximately four to five weeks before Board examinations after which supposedly students engages themselves in the revision/preparations. So, the usual practice is that teachers in grade X completes almost 100 % of the syllabus before trial examination so that they get enough time to revisit previous lessons and prepare for Board examination.

However, the academic performance of class X students in mathematics, both in home examinations and board examinations, has consistently been below average. The average marks obtained by students in mathematics have consistently fallen below the mean marks for other subjects. For example, according to Pupil Performance Reports of 2018 and 2019, the mean marks without continuous assessments were 38.71% and 37.83% in 2018, and 41.45% in 2019, which was the lowest mean mark compared to other subjects in most academic years. Furthermore, the performance in mathematics at Druklingthang Central School has been comparatively lower than their performance in other subjects. The school’s mean mark in mathematics were 56.5% and 44.83% in 2018 and 2019, respectively, while the

national mean marks were 56.83% and 52.02% for the same years.

The current approach to preparing Grade X students for board examination involves only regular revision, typically consisting of teachers solving questions for students. In many cases, teachers or students gather past papers and solve them together. Occasionally, teachers may assign students the task of independently solving past papers from at least last five years and submitting them as an assignment. However, it is evident that students often resort to passive copying instead of actively investigating the solutions and solving the papers on their own.

Therefore, in this study I investigated the effects of Thinking Aloud Pair Problem Solving Strategy (TAPPSS) in a mathematics class during preparation session on Grade X student’s mathematics performance/achievement in Druklingthang Central School, Paro.

### Competence

The researcher is a mathematics teacher currently working in Wanakha Central, Paro. He has completed his bachelor of education (B.Ed) specializing in Mathematics and Physics from Samtse College of Education in 2011 and Master of Science (MSc.) in Applied mathematics from South Asian University in New-Delhi, India in 2018. He has learnt idea of action research through attending school based in-service program (SBIP) on Action research in Wanakha C.S. in 2019 and a professional development program on action research organized by Dawakha L.S.S and facilitated by chief research officer from Anti-Corruption Commission, Thimphu. Moreover, he has done a conventional research for college proceedings while undergoing his M.Sc. at South Asian University in graph theory, his subject of specialization (Embedding  $k$ -regular graph in  $k+1$ -regular graph).

Mr. Singye a former teacher in Wanakha C.S. who is currently working as a research officer in Anti-Corruption Commission, Thimphu is the critical friend for this research. He has a bachelor’s degree (B.Ed) in English from Paro college of education and Master of Arts (M.A) in Applied linguistics/TESOL from Payap University, Thailand. He has published a research paper in 2020 named “an investigation into using Kagan cooperative learning model to enhance English oral communication ability of Bhutanese students”.

Grade X students from Druklingthang Central School were a part of this study. 100% of them were residing as boarding students due to the pandemic. They had the access to internet facilities in the school IT lab. However, in general most of them struggled to perform better in mathematics compared to other subjects.

### Literature review

Thinking aloud pair problem solving, which was first developed by Arthur Whimbey, and aims to better understand thinking among the students (Whimbey & Lochhead, 1999) and to develop students' cognitive processes associated with problem solving (Kotsopoulos, 2010). Thinking aloud pair problem solving is mainly based on thinking aloud and listening (Jeon *et al.*, 2005) [6].

Whimbey and Lochhead (1999) [6] mentioned that thinking aloud during problem solving aims to ensure that students "do not skip steps in their reasoning, nor miss facts in drawing conclusions" (p. 23). This procedure may also help in identifying different kinds of students' weaknesses, errors and strategies in problem solving (Montague *et al.*, 2011) [9]. This strategy requires students to have some background knowledge of the question they are solving. So, if we use this strategy in our normal lesson where a student solves problem for the first time then it won't bring any significant improvement in the achievement of students.

The findings of a study done by Jeon *et al.* (2005) [6]. Showed that the use of TAPPS method helped students in being aware of their thinking process and improve their problem-solving skills, especially in understanding the problem-solving questions prepared in this study. However, it did not help improve students' conceptual knowledge. "If student's conceptual understanding were weak to start with, the problem-solving strategy would not help much during the exercise. (p.26)". This is in line with the findings by Jeon *et al.* (2005) [6] which reported that "the problem-solving strategy did not improve students' conceptual knowledge more than conventional methods" (p. 1563).

According to Shahril (2014) [8]. The results of this study indicated that the TAPPS method could help improve students' problem solving behaviour. However, it should be noted that this study did not show that using this method alone could help students improve their mathematics achievement" (p. 149).

However, Jeon *et al.* (2005) [6] observed in their investigation on the effectiveness of TAPPS in improving problem solving performance of high school chemistry students that students in both the individual and TAPSS groups performed better in problem solving compared to the control group. They found that students in the individual and TAPSS groups performed better in recalling the related law and mathematics execution. The students in TAPSS group also performed better than the others on conceptual knowledge. Jeon *et al.* (2005) [6] also stated that the verbal interactions between the solvers and listeners could help the students be "more cognizant of both their own thinking and the thinking of other students" (p. 1564).

Therefore, I have attempted to study the effect of TAPPS strategy as a revision tool. As in the time of revision students will have completed the syllabus already and will have prior background knowledge on the particular concept, so problem solver and listener won't get distracted due to lack of knowledge in the process.

To investigate the effectiveness of the TAPPS strategy as a revision tool, two action research questions were formulated.

### Action Research Question

1. Can Think Aloud Pair Problem Solving Strategy (TAPPS) help improve class X students' performance in mathematics?
2. Effect of TAPSS as revision tool in the performance of class X students in mathematics (*Non-linear function & Equation and Trigonometry*).

### Methodology

Action research model used was randomized control Group Pretest-Posttest Design as shown in Figure 2. Sections were randomly selected as Control and treatment group based on coin toss. The number of participants in control group and treatment group were 22 each. Pre-test was conducted for control as well as treatment group. Then TAPPS strategy were used with treatment group during the revision, in the other hand normal revision was done with the control group. Intervention was used for two months and a post test was conducted both for control and Treatment group. Pretest and post questions were made using Bloom's taxonomy. The analysis using Paired sample t-test, individual sample t-test and ANOVA test were done.

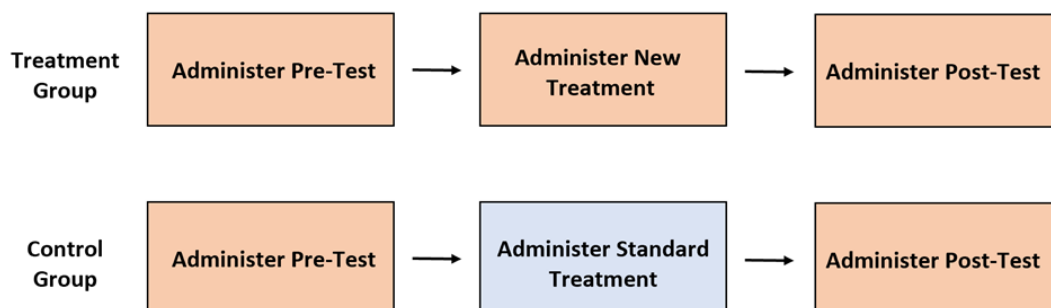


Fig 2: Experimental research model

In this study, I investigated the effects of conducting Thinking Aloud Pair Problem Solving Strategy (TAPSS) in a mathematics class on Grade X student's mathematics performance/achievement in Druklingthang Central School, Paro.

### Action Plan

The participants for this study were grade X students of Druklingthang Central School, Paro. There were 22 students in experimental group (12 boys and 10 girls) and 22 students

in control group (12 boys and 10 girls). However, there were some absentees during the data collection period from both experimental as well as control group. Therefore, only data from 20 students each from the experimental group and control group were taken into account for the study.

Baseline data for this action research was collected through a pretest (N=44) from two sections of class X students except for four who were absent that day. The questions were from the two topics Non-linear function & Equation and Trigonometry. Baseline data was collected on 10<sup>th</sup> December. After the baseline data collection, intervention strategies were administered for the two sections. In one section normal revision where teacher clarifies doubts brought by students was done and in the other section revision was done using TAPSS strategy. The intervention was carried out for two months, post-intervention data were collected in February through post-survey questionnaires (N=40). Eight-question questionnaire on a Likert-scale was developed to learn from the participants (N=40) whether the TAPPS strategy helped them achieve better grades or not.

### Intervention Phase

To investigate the effect of ‘Thinking aloud pair problem solving strategy’ developed by Arthur Whimbey, which aims at better understanding the thinking among the students (Whimbey & Lochhead, 1999) and to develop students’ cognitive processes associated with problem solving (Kotsopoulos, 2010) the TAPPS strategy was used with the treatment group.

Students in the treatment groups were assigned a partner each. The pair decided between them to assume a role each of a problem solver and listener. The problem solver verbalized all the steps while solving a problem and the listener observed the process without interfering in the process and they switched their roles to complete the cycle. This we believed helped students in the pair to better understand the problem that they have solved together. Also, Jeon *et al.* (2005) <sup>[6]</sup> stated that the verbal interactions between the solvers and listeners could help the students be “more cognizant of both their own thinking and the thinking of other students” (p. 1564). The students in the control groups did normal revision which included solving past

year’s exam papers and solving few questions by the subject teacher.

This intervention was used for two months (15<sup>th</sup> December to 15<sup>th</sup> February). Then a post-test was conducted with control as well treatment group. In addition to this we also conducted a survey with both the groups for our data triangulation. Finally data collected were analyzed using t-test, ANOVA test and graphs.

### Data collection

The action research model used was randomized control Group Pretest Posttest Design. The control and treatment groups were decided based on coin toss. The number of participants in control group and treatment group were 20 each. Questions for pre-test was prepared using Blooms taxonomy for the two targeted topics (i.e. *Non-linear function & Equation and Trigonometry*) and then the Pre-test was conducted for control as well as treatment group with the same set of questions.

During the revision process the TAPPS strategy was administered to treatment group, while normal revision was conducted with the control group. The Intervention were used for two months (15<sup>th</sup> December to 15<sup>th</sup> February) and then a post test was conducted both for control and Treatment group again using the same set of questions.

Set of 8 Likert scale questions were created to gather data and determine whether there was any improvement in mathematics achievement. The questionnaire were administered to the treatment group only.

### Data Analysis

In order to answer my action research question, results from the pre-test and the post-test of both experimental and control groups were analyzed quantitatively using the Paired sample t-test, individual sample t-test and ANOVA test to measure any significant difference in students’ mathematics achievement.

In order to investigate the differences in mathematics achievement between the control and treatment group an independent sample t-test and ANOVA test was computed as shown in Table 1 and 2 respectively.

**Table 1:** Independent sample t-test

#### t-Test: Two-Sample Assuming Unequal Variances

|                              | Control    | Treatment |
|------------------------------|------------|-----------|
| Mean                         | 14.3875    | 19.9875   |
| Variance                     | 48.1544408 | 39.818914 |
| Observations                 | 20         | 20        |
| Hypothesized Mean Difference | 0          |           |
| df                           | 38         |           |
| t Stat                       | -2.6700995 |           |
| P(T<=t) one-tail             | 0.00554802 |           |
| t Critical one-tail          | 1.68595446 |           |
| P(T<=t) two-tail             | 0.01109604 |           |
| t Critical two-tail          | 2.02439416 |           |

The post-test mean for the control group (14.3875) and treatment group (19.9875) was compared. It indicated that the students in treatment group performed better than the ones in the control group. The P-value ( $P = 0.01109604$ ) indicated

that there was a significant difference in the achievement of students in Treatment group compared to those in control group.

**Table 2:** ANOVA test

| SUMMARY   |       |        |         |             |  |  |
|-----------|-------|--------|---------|-------------|--|--|
| Groups    | Count | Sum    | Average | Variance    |  |  |
| Control   | 20    | 97.25  | 4.8625  | 21.38470395 |  |  |
| Treatment | 20    | 235.25 | 11.7625 | 20.03601974 |  |  |

| ANOVA               |            |    |             |            |                       |             |
|---------------------|------------|----|-------------|------------|-----------------------|-------------|
| Source of Variation | SS         | df | MS          | F          | P-value               | F crit      |
| Between Groups      | 476.1      | 1  | 476.1       | 22.9884926 | 0.0000251640981198188 | 4.098171731 |
| Within Groups       | 786.99375  | 38 | 20.71036184 |            |                       |             |
| Total               | 1263.09375 | 39 |             |            |                       |             |

Table 2 shows that the result investigated using the ANOVA single factor test. In the summary table number 2, we see the sum for control group is 97.25 which is positive so we can say that there is an improvement in control group as well. This seems logical as the study was conducted after the completion of the syllabus to see the effect of normal revision and using TAPPS method as a revision tool. However, the sum for treatment group is 235.25 which shows TAPPS method helped improve student's achievement in

mathematics when they were used as a revision tool. Here too the P-Value is way less than 0.05 therefore we can conclude that there was a significant difference in the mathematics achievement of students when TAPPS strategy was used as a revision tool.

In order to investigate the performance of the students in treatment group before and after administering the TAPPS strategy a Paired sample t-test was computed as shown in Table 3.

**Table 3:** Paired sample t-test

t-Test: Paired Two Sample for Means

|                              | Pre-test     | post-test   |
|------------------------------|--------------|-------------|
| Mean                         | 8.225        | 19.9875     |
| Variance                     | 11.7625      | 39.81891447 |
| Observations                 | 20           | 20          |
| Pearson Correlation          | 0.728805169  |             |
| Hypothesized Mean Difference | 0            |             |
| df                           | 19           |             |
| t Stat                       | -11.75192223 |             |
| P(T<=t) one-tail             | 1.84E-10     |             |
| t Critical one-tail          | 1.729132812  |             |
| P(T<=t) two-tail             | 3.68E-10     |             |
| t Critical two-tail          | 2.093024054  |             |

**Null Hypothesis:** there is no significant improving in mathematics achievement when TAPPS strategy is used during revision.

**Alternate Hypothesis:** There is significant improvement in mathematics achievement when TAPPS strategy is used as a revision tool.

The P-values is found to be less than 0.05 as shown in Table 3. Therefore, it enables us to reject our null hypothesis and

accept the alternate hypothesis that there is a significant improvement in the mathematics achievement when TAPPS strategy was used during the revision.

It was found that that there was significant difference in the mean during pre-test (8.225) and post-test (19.9875), which indicated that TAPPS strategy used during revision helped students perform better as compared to normal revision.

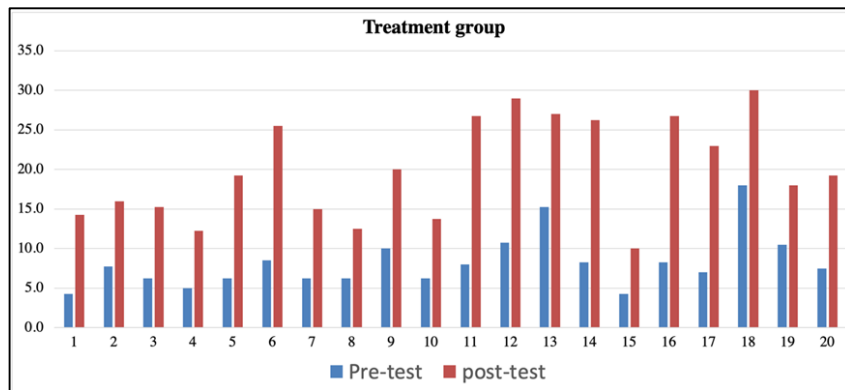


Fig 3: Mean mark for pre-test and post-test for treatment group

The trend in the marks obtained by the students in pre-test and post-test as shown in the bar Graph above clearly indicates that the TAPPS strategy has helped students to perform better compared to the normal revision.

**Questionnaire**

8 questions on Likert scale were developed to triangulate data as to whether there was an improvement in the mathematics achievement or not and was administered to the treatment group. The overall percentage of responses of the 8 questions

are shown in figure number 4 given below. The result from the responses given by the students in the experimental group showed that TAPPS strategy helped in the mathematics achievement. For example, question number 8 stated “Thinking aloud helped me to remember the steps needed to factor a quadratic equation” and the 45% opted strongly agree, 35% agree, 15% neutral, 5% disagree and 0% strongly disagree. This proves that administering the TAPPS strategy as a revision tool helped in the mathematics achievement.

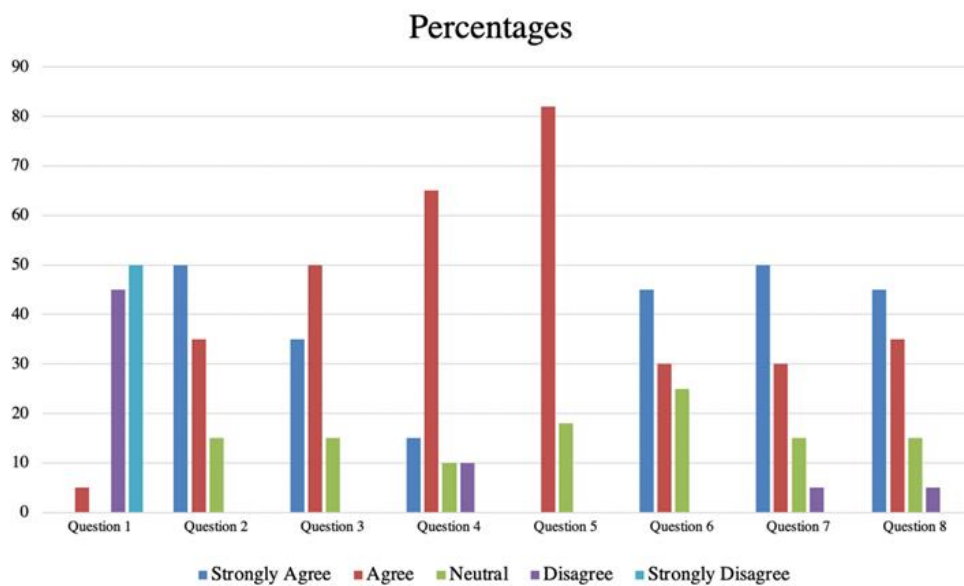


Fig 4: Categorical responses of Likert-scale questions in percentage

**Conclusion**

The findings of this study showed that the use of TAPPS method as a revision tool helped students improve their conceptual knowledge. There was significant improvement in the mathematical achievement for the students where TAPPS strategy was administered. The result shown by Independent t-test, paired sample t-test and ANOVA single factor test all proved that TAPPS strategy brought significant improvement in the mathematical achievement of the students. This was further confirmed from the result obtained by the questionnaire using the Likert scale data collection method. It supported that TAPPS strategy when used as a revision tool helped improve their conceptual knowledge. The limited language proficiency and mathematical vocabulary pose significant challenge in implementing the

TAPPS strategy. In addition to it the lack of previous knowledge in the topic might distract the student and interrupt the process while using the TAPPS strategy. However, in my study I used this problem-solving strategy (TAPPS) as a revision tool during revision/preparation process. Therefore, students had this conceptual knowledge that is required to tackle the mathematical problem beforehand to work with during the learning activity using TAPPS strategy and so this strategy helped them better in applying their knowledge using the strategy to solve the problems given to them. This is in line with Jeon *et al.* (2005) [6] where they did their study on the effectiveness of TAPPS method in the context of chemistry lessons and have found that TAPPS “improved students’ conceptual knowledge and increased success rates on solving problems” (p. 1564).

### Concerns and limitations

This study was conducted with a small group of students of Druklingthang central school and it worked well. Therefore, this result might be consistent with some researchers and may not be the same for others especially for lower grades.

Some difficulty faced during the initial period was that some students were reluctant in using TAPPS strategy when a problem was presented to them as they faced difficulty in verbalizing their thoughts due to poor command over the language. This is consistent with the study by Fan and Yeo (2007), "students' ability in their command of the language (English) was a crucial factor in determining their ability to perform well in oral presentation tasks" (p. 94).

### Recommendation/Future research

In this study we investigated the achievement of students in mathematics using the TAPPS strategy as a revision tool or during the revision/preparation for examination and it showed significant improvement in mathematics achievement. Future action research in other subjects can also be done as this may prove to be a better teaching and learning strategy in the subjects that involves problem solving. For example, the study by Jeon *et al.* (2005) <sup>[6]</sup> where they did their study on the effectiveness of TAPPS method in the context of chemistry lessons and have found that TAPPS "improved students' conceptual knowledge and increased success rates on solving problems" (p. 1564).

A potential suggestion for future action research could involve conducting a study on the efficacy of the TAPPS method in examining problem-solving behavior and achievement within a mixed-ability pair (consisting of a high-performing student and a low-performing student) as well as within a high-ability pair (comprised of high achievers).

### References

1. Anderson LW, Krathwohl DR. Kerangka Landasan Untuk Pembelajaran, Pengajaran, dan Assesmen [Framework for Learning, Teaching and Assessment]. Yogyakarta: Pustaka Pelajar, 2001.
2. Bhutan Council for School Examinations and Assessment. Pupil performance report, 2018-2020, Volume 13. School Examination Division, BCSEA. [http://www.bcsea.bt/uploads/publications/PPR%202019\\_1626325664.pdf](http://www.bcsea.bt/uploads/publications/PPR%202019_1626325664.pdf)
3. Bhutan Council for School Examinations and Assessment. Pupil performance report 2019-2020, Volume 13. School Examination Division, BCSEA. [http://www.bcsea.bt/uploads/publications/PPR%202020\\_1626324345.pdf](http://www.bcsea.bt/uploads/publications/PPR%202020_1626324345.pdf)
4. Bhutan Council for School Examinations and Assessment. Pupil Performance report 2020, Volume 13. School Examination Division, BCSEA. [http://www.bcsea.bt/uploads/publications/PPR%202021\\_1626324248.pdf](http://www.bcsea.bt/uploads/publications/PPR%202021_1626324248.pdf)
5. Fan L, Yeo SM. Integrating oral presentation into mathematics teaching and learning: An exploratory study with Singapore secondary students. Paper presented at the American Educational Research Association (AERA) Annual Meeting, San Francisco, California, USA, 2006, 7-11.
6. Jeon K, Huffman D, Noh T. The effects of thinking aloud pair problem solving of high school students' chemistry problem-solving performance and verbal interactions. *Journal of Chemical Education*. 2005; 82(10):1558-

- 1564.
7. Kotsopoulos D. An analysis of talking aloud during peer collaborations in mathematics. *International Journal of Science and Mathematics Education*. 2010; 8:1049-1070.
8. Mahadi MAH, Shahrill M. In pursuit of teachers' views on the use of textbooks in their classroom practice. *International Journal of Education*. 2014; 6(2):149-158.
9. Montague M, Krawec J, Rosenzweig C. Metacognitive strategy use of eight-grade students with and without learning disabilities during mathematical problem solving: A think-aloud analysis. *Journal of Learning Disabilities*. 2011; 44(6):508-520.
10. Polya G. How to solve it? Doubleday.
11. Whimbey A, Lochhead J. Problem solving and comprehension. Lawrence Erlbaum Associates, 1986.
12. Winkel WS. Psikologi Pengajaran [Teaching Psychology]. Yogyakarta: Media Abadi, 2007.