The influence of TAPPS technique on students’ problem solving abilities

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Abstract. This research aimed at investigating the influence of thinking aloud pair problem solving (TAPPS) technique toward the students’ abilities in problem solving, based on gender and learning styles. This research was conducted at grade eight in a middle school in Padang, West Sumatra Indonesia, using a quasi experimental method. The sample of the research was two groups of the students that have been selected randomly. Data were collected through questionnaire and test. Mann Whitney U and Kruskal Wallis tests were used in analyzing the data. The results of the research show that 1) problem solving abilities of the students who have been taught using TAPPS technique is significantly higher than those who have been taught using conventional technique; 2) problem solving abilities of female students is significantly higher than male students; 3) the students who has visual learning style are better than those who has auditory and kinaesthetic learning styles in problem solving abilities; 4) there is no interaction between the techniques and gender nor learning styles in influencing the problem solving abilities of the students. It can be concluded that the TAPPS technique gives significant influence on students’ problem solving abilities based on gender and learning styles.

1. Introduction
Problem solving is one of important aspects in learning mathematics. It is not only the ultimate goal but also the vehicle for being success in of learning mathematics. [1] mentioned that solving problems are a goal as well as a major means of learning mathematics. Because of that, problem solving must be an integral of all learning mathematics activities. Moreover, problem solving should not be isolated from all of mathematics learning. Problem solving is the foundation of many mathematical activities [2]. Therefore, it becomes the most basic unit of classroom instruction [3]. Long before that, Polya already stated that problem solving is the specific achievement of intelligence, while the intelligence is a special gift for people [4]. In addition, he mentioned that solving problems are the most important characteristic of human activity.

The importance of problem solving is also reflected in the number of researches conducted in this field. Researcher and math educators continuously discuss and analyze problem solving from various perspectives. The recent studies can be seen from the works of [5-7]. However, many results showed the poor performance of the students in problem solving or solving word problems. [8] mentioned that many students struggled to accomplish problem-solving tasks, while it was found that 45% of eighth-grade students were faced difficulties in solving a word problem that required dividing fractions.

Some causes for the difficulties were lack of prerequisite knowledge and skills and lack of understanding of mathematical basic concepts [9, 10]. In addition, the students also found difficulties in understanding the problems because of language barriers and lack of experiences in problem solving.
The later was because most teachers rarely introduce non-routine problems to the students when teaching mathematics in the classrooms [11, 12]. The main reason for this condition is that the teachers themselves unsure about their competence in problem solving. They are also not confident to handle the pedagogical demands that are required when solving the problems [11]. Besides, the teachers do not pay serious attention to problem solving because it rarely found in national mathematics examination. Most problems given in national mathematics examination only required applying the formulas or algorithms and rarely connected to real life contexts [13]. Similar problems were also found in the previous researches conducted in West Sumatra Indonesia (see [14-16]). To overcome the students’ weaknesses in problem solving, we implemented thinking aloud pair problem solving (TAPPS) technique.

This technique have been chosen because of its potential to improve problem solving abilities. According to [17], in solving a problem using TAPPS technique, the students will work collaboratively in pair. They will take a role as the listener and the problem solver in turn by following a certain protocol. Several research findings showed that TAPPS and other similar techniques very potential in improving problem solving abilities [18, 19]. It is because the students exchange the role as problem solver and listener and exchange the explanations, thoughts, and reasoning, during the thinking aloud process. Besides, the student is also asked to examine the ideas of his or her pair [20].

Gender and learning styles were also involved as two moderator variables in this research as several previous researches indicated that the two variables related to problem solving [see 21 – 25]. Several researches concluded that there were differences in mathematical problem solving abilities based on gender. Some results showed that male students outperformed female students in their studies [26 – 30], while [31] found that gifted girls are better than gifted boys regarding their abilities in mathematical problem solving. As the results of these studies are not consistent, it would be a challenge for us to investigate more about gender differences in problem solving by implementing TAPPS technique.

The learning styles (visual, kinesthetic, auditory) also has a strong connection to problem solving abilities. They will determine the approach or strategy used by the students when solving a problem, as it can be seen from the work of [24, 32 – 35]. The learning styles are also related to gender differences. As males and females have different learning styles, then they will also respond differently in solving a mathematical problem in the classroom [36]. [24, 35] mentioned that the students’ strategies in problem solving are influenced by their tendencies in using spatial or verbal skills. Therefore, gender will be a factor that create the differences in problem solving abilities.

The questions that would be addressed in this research are: 1) Is problem solving abilities of the students who have been taught using TAPPS technique significantly higher than those who have been taught using conventional technique? 2) Is there the difference in problem solving abilities between male and female students? 3) Is there the difference in problem solving abilities among the students who have visual, auditory, and kinesthetic learning styles? 4) Is there interaction between the techniques and gender as well as the learning styles in influencing the problem solving abilities of the students?

2. Method
In this study, the influence of TAPPS technique on the students’ mathematical problem solving ability was investigated by applying a quasi-experimental method. This research also involved gender and learning styles as moderator variables. The research was conducted at grade eight in a middle school in Padang Indonesia. Two classes were chosen randomly as the sample of this research; one class as the experimental group and the other class as the control group. The students of the experimental group were taught using TAPPS technique, while the students in the control group were taught using conventional technique.

The data were collected by using test and questionnaire. The test was used to measure the mathematical problem solving ability of the students, while the questionnaire was used to identify the learning styles of the students. Both instruments were satisfied the criteria of validity and reliability, after validation and try out processes. After conducting normality tests, collected data were analyzed using Mann Whitney U and Kruskal Wallis tests.
3. Results and Discussion

After analyzing the data, the students’ mathematical problem solving abilities were grouped based on their gender and learning styles in Table 1.

**Table 1. Students’ mathematical problem solving abilities based on gender and learning styles**

|                     | Experiment Group | Control Group |
|---------------------|------------------|---------------|
|                     | N    | \( \bar{x} \) | S   | N    | \( \bar{x} \) | S   |
| **Gender**          |      |            |     |      |            |     |
| Male                | 16   | 14.06      | 3.21| 16   | 12.37      | 3.99|
| Female              | 16   | 17.06      | 2.43| 18   | 14.27      | 4.25|
| **Learning Style**  |      |            |     |      |            |     |
| Auditory            | 13   | 15.07      | 3.40| 15   | 12.87      | 4.75|
| Visual              | 10   | 16.30      | 2.83| 11   | 14.00      | 3.84|
| Kinesthetic         | 9    | 15.44      | 3.47| 8    | 13.50      | 3.89|

The results normality tests showed that some groups of data did not meet the criteria of normality distribution. Therefore, the comparisons between the experiment and the control group as well as between male and female students were tested using Mann Whitney U test. Meanwhile, the comparison among the learning styles was tested using Kruskal Wallis test. The conclusions of the data analysis are presented on Table 2.

**Table 2. The results of the hypothesis testing**

| No | Comparison between:                                      | Sig.    |
|----|---------------------------------------------------------|---------|
| 1  | Experiment and control group                            | 0.026   |
| 2  | Male and female students                                | 0.005   |
| 3  | Auditory, Visual, and Kinesthetic learning styles       | 0.042   |

Based on the results of the hypothesis testing, it is revealed that the problem solving abilities of the students who have been taught using TAPPS technique is significantly higher than those who have been taught using conventional technique. That is because TAPPS technique gives the students more intents and meaningful experiences in solving mathematical problems [20]. This conclusion is similar to those found by [18] and [19].

The next result shows that the problem solving ability of the female students is significantly higher than male students. This condition is valid for each aspect of problem solving (understanding the problems, choosing and implementing the strategies for solving the problems, and reflecting on problem solving activities). The result of this research is in line with the finding of [31] in which female students outperformed male students in problem solving.

As in TAPPS technique, the students have the role as the problem solver and the listener in turn, it was predicted that the students who have kinesthetic learning style will get more benefit. However, this research revealed that the students who have visual learning style are better than those who have auditory and kinesthetic learning styles. The reason for this finding is the problem solving activities in this research are dominated by visualizing things using figures, tables, symbols, etc. Regarding the interaction between independent and moderator variables, it was found that there is no interaction between the techniques and gender nor learning styles in influencing the problem solving abilities of the students. It can be concluded that the TAPPS technique gives significant influence on students’ problem solving, especially for female students as well as for the students who have visual learning style. It means that when the teachers want to use TAPPS technique to improve problem solving abilities, they do not need to consider gender and learning styles of the students.

4. Conclusion

Based on the results of this research, it can be concluded that 1) problem solving abilities of the students who have been taught using TAPPS technique is significantly higher than those who have been taught using conventional technique; 2) problem solving abilities of female students is significantly
higher than male students; 3) the students who has visual learning style are better than those who has auditory and kinesthetic learning styles in problem solving abilities; 4) there is no interaction between the techniques and gender nor learning styles in influencing the problem solving abilities of the students. It can be concluded that the TAPPS technique gives significant influence on students’ problem solving, especially for female students as well as for the students who have visual learning style.

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