Thinking Aloud Pair Problem Solving (TAPPS) Method: The Effect of Understanding Physics Concepts and Communication in High Schools in Indonesia

Siti Anisatur Rofiqah\textsuperscript{1}, Widayanti\textsuperscript{2*}, Ahmad Rozaqi\textsuperscript{3}
\textsuperscript{1,2}Teacher Training College of Education, Sukaraja, Indonesia \textsuperscript{3}Sabili Muqorrobien Islamic Boarding School, Indonesia

\*Correspondent author: widayanti@radenintan.ac.id

Abstract. The purpose of this research is to improve the understanding of scientific concepts and communication of high school students in Indonesia. The method used in this research is quasi experiment method with the pre-test and post-test. Subjects of the research were obtained from random cluster sampling with 60 students. The experimental class was given treatment of the Thinking Aloud Pair Problem Solving method and the control class was given the treatment of the discussion method. The results of this study indicate an increase between the pre-test and post-test understanding of concepts and scientific communication both in the experimental class and the control class. However, the experimental class experienced more significant escalation with an effect size value of 0.3 in the medium category. The further research need to be applied the use of Thinking Aloud Pair Problem Solving method in more than one class to see the consistency of Thinking Aloud Pair Problem Solving method in improving students' understanding of concepts and scientific communication.

1. Introduction
There are several levels of formal education applied in Indonesia. Some of these levels include levels of early childhood education, kindergarten, elementary school / (madrasah ibtidaiyah), junior high school / (madrasah tsanawiyah), senior high school / (Madrasah Aliyah) / vocational high school, undergraduate, postgraduate and doctoral courses. Each level of education has different indicators of achievement according to the level of school pursued [1]. In high school, the students are prepared to continue their tertiary education [2]. It is hoped that high schools can produce the best graduates, therefore they can continue to a higher level.

One of the efforts created in order to get the best graduates is by understanding each concept of material learned and can explain those concepts to their colleagues [3–5]. Understanding the concept is very important for every student, students who understand the concept will be easy to solve problems in various ways [6-7]. In particular, problems that related to daily life events [8]. One of them is the physical phenomenon that is always applied in daily life. Physic studies various sciences including land, air and water [9]. Indonesia has 2/3 of the waters of the land area [10]. Therefore, it is very important for the students to study waters (fluids), hence they can overcome all the problems of Indonesian waters through the best solutions [11-12]. This matter needs to be trained for students through certain methods.
There are several methods are commonly used in learning, but those methods must be adjusted to the indicators to be achieved [13-14]. As for several methods used in learning process including: Problem Based Learning (PBL) [15-16], Project Based Learning (PjBL) [14-17], Inquiry [18], Thinking Aloud Pair Problem Solving (TAPPS) [19-21] and so on. Each of method has advantages and disadvantages. In this study the TAPPS method is applied because the method leads students to solve problems scientifically through the role of problem solver and listener groups [21-22]. It is hoped that the role can boost students to easily understand the concept of matter and can communicate scientifically well.

Some previous studies overcome the understanding of concepts by applying media [23-24], applying the Auditory Intellectually Repetition model [25], applying the PBL model [26-27], and applying the ARIAS model [15-28]. Other studies overcome scientific communication by applying inquiry methods [29-30], applying a jigsaw model [31], applying a think-talk-write model [32], and applying the problem solving model [33]. In addition, the Thinking Aloud Pair Problem Solving (TAPPS) method has been implemented to improve learning outcomes [20-21], problem solving abilities [22] and creative thinking [19]. In previous studies, none researcher overcome the understanding of concepts or scientific communication by applying the Thinking Aloud Pair Problem Solving (TAPPS) method.

2. Method

This research used a quasi experiment method [34]. With pre-test and post-test design. Subjects of the research were taken by cluster random sampling technique [35]. The subjects involved in this study, including the control class and experimental class, amounted to 60 high school students. The study design is shown in following table 1.

| Class          | Pre-test | Treatment | Post-test |
|----------------|----------|-----------|-----------|
| Experiment     | X        | X         | X         |
| Control        | X        | -         | X         |

In the experimental class, was given a treatment of Thinking Aloud Pair Problem Solving (TAPPS) method and the control class was given treatment through conventional methods (discussion method). This study uses instruments in the form of matter understanding concepts and scientific communication questionnaires. All instruments have been tested for validity and reliability before applied to students. Problem understanding concepts were analyzed using Effect Size and questionnaires were analyzed using scores. Tables 2 and 3 show the N-gain criteria, effect size and questionnaire scores. Effect size can be calculated using the following Cohen formula [36].

\[
d = \frac{m_A - m_B}{\left(\frac{sd_A^2 + sd_B^2}{2}\right)^{1/2}}
\]

Descriptions:
\(d\) = Effect size
\(m_A\) = Average value of experimental class
\(m_B\) = Average value of control class
\(sd_A\) = Standard deviation of the experimental class
\(sd_B\) = Standard deviation of the control class
Table 2 effect size criteria

| Effect size | Criteria |
|-------------|----------|
| d < 0.2     | Small    |
| 0.2 ≤ d ≤ 0.8 | Medium  |
| d > 0.2     | High     |

Table 3 Interpretation of scientific communication questionnaire scores

| Score | Level of achievement (%) | Descriptions |
|-------|--------------------------|--------------|
| 1     | 0 ≤ P ≤ 20               | Worse        |
| 2     | 20 < P ≤ 40              | Bad          |
| 3     | 40 < P ≤ 60              | Enough       |
| 4     | 60 < P ≤ 80              | Good         |
| 5     | 80 < P ≤ 100             | Excellent    |

3. Result and Discussion

3.1. Result

This research has a design in its application. The following designs are applied to the learning of the experimental class and the control class.

Table 4 learning design of experimental class and control class

| Treatment | Experimental class | Control class |
|-----------|--------------------|---------------|
| Step 1    | - Teacher start the learning by delivering the learning materials | - Teacher start the learning by delivering the learning materials |
|           | - Teachers and students discuss examples of problems together | - Teachers and students discuss examples of problems together |
| Step 2    | - The teacher divides students into groups. Each group consists of two students | - The teacher divides students into groups. Each group consists of five students |
|           | - Students are leaded to sit in pairs in their own group | - Students are directed to sit in groups |
|           | - Each group determines who is the problem solver and who is the listener | |
|           | - The teacher distributes problem sheets consisting of 2 problems in each group and those who act as problem solvers are given two minutes to study the problem | |
| Step 3    | - **Problem solver** read the question explicitly and loudly to the **listener** | - The teacher shares the problem to each group. |
|           | - **Problem solver** starts to solve their own problem, problem solver expresses all opinions and ideas, also states all the steps that will be taken to solve the problem and explains what, why, and how these steps are taken so that listeners understand the explanation. | - Each group is given four questions that must be completed by each group. |
|           | - The teacher monitors students’ activities and if pairs of student have difficulty, educators can help them by becoming a **listener** and giving questions that are actually help the students into something that they need | - Each group takes turns solving each question given and explaining it to colleagues in front of the class. |
|           | | - Other groups may ask if they are not familiar with the described problem solving |
- Listener be in charge to listen and understand every step taken by the problem solver in detail. If you don't understand, then ask the problem solver.
- Listener is not allowed to add the answer from problem solver because listener only right to inform if problem solver does a mistake by giving a question that lead into right answer.

Step 4
- If the problem in the first problem sheet has been solved by the problem solver, each student switches roles. Problem solver becomes listener and vice versa.
- After the switching role, students share the second problem sheet that also consists of two similar problems with the same level of difficulty.
- Each group back to discuss as done in step 3 to overcome the new case.

Step 5
- The teacher and students discusses the problem given that already discussed by each group.
- The teacher and students discuss problems that are difficult for students to understand

Step 6
- Teacher rewards the best problem solver, the best listener, and the best group.
- Teacher rewards the best group

After applying the research design in the experimental class and the control class by distributing research instruments, the data analysis results are obtained as follows.

**Table 5** recapitulation of the pre-test and post-test scores of the experimental class

| Pre-test Descriptions | Post-test |
|-----------------------|-----------|
| 72 Highest score      | 92        |
| 8 Lowest score        | 40        |
| 1212 Total score of experimental class | 2324 |
| 40,4 Score average    | 77,5      |

**Table 6** recapitulation of the pre-test and post-test scores of the control class

| Pre-test Descriptions | Post-test |
|-----------------------|-----------|
| 68 Highest score      | 92        |
| 8 Lowest score        | 60        |
| 1256 Total score of control class | 2208 |
| 41,9 Score average    | 73,6      |

**Table 7** data effect size of the experimental class and control class

| Gain average of experimental class | Gain average of control class | Effect Size | Criteria |
|------------------------------------|-------------------------------|-------------|----------|
| 37,1                               | 31,7                          | 0,3         | Medium   |
Table 5 shows the recapitulation result value of the understanding static fluid material concept in the pre-test and post-test of the experimental class, meanwhile table 6 shows the recapitulation result value of the understanding static fluid material concept in the pre-test and post-test of the control class. In addition to data of understanding concept, data analysis results on scientific communication skills is also obtained, according to the instrument in the form of a questionnaire given to students. Figure 1 below shows the results of scientific communication.

3.2. Discussions
Static fluid is the material applied in this study. The material is related to water. The material is often found in daily life. However, not all students can understand the law physic of static fluid material. Hence, this research aims to improve students’ understanding of concepts. In addition to understanding the concept, the research also desire to improve student scientific communication. The results of understanding the concepts in this study are shown in tables 5, 6 and 7. The results of the pre-test scores in the experimental class and the control class are not significantly different. However, in the post-test results of the experimental class and the control class there was a significant increase. Therefore, the value of the effect size obtained has moderate criteria. Effect size value used to measure the difference that occurs in the results of the experimental class and the control class. This can be happen because the differences of treatment in the experimental class and the control class.

In the experimental class, students were divided into groups consisting of only two students who had the role of problem solving and listener, in the control class each group consisted of five students who had the same role. Those divisions have significant influences, the fewer the member, the more their responsibility. Whereas in groups that consist of huge members will also affect toward their responsibility for the group, which dominates will always dominate the group and vice versa.

Furthermore, in the experimental class, students switch the roles. In the discussion of the previous problem, a problem solver exchanged into a listener and vice versa. Therefore, students experience the same role. Both difficulties and conveniences, both can solve problems and explain them. Whereas, in the control class, each group is jointly responsible without sequential change of roles. Hence, only active students have more roles in the group, while students who tend to remain silent will remain silent without having the opportunity to be more active because of the distrust of them. The case is related to previous research that by giving equal opportunities will facilitate students in understanding the material [37-38]. In addition, by listening and solving problems directly with one's own thoughts, it will be easier to understand the concepts learned [39-41].
In addition to the understanding concepts, this research also succeeded in improving scientific communication. Through questionnaires given to students before and after treatment. The percentage results showed a significant increase. At first, there is no any significant difference before the given treatment both in the experimental class and the control class. However, after being given a scientific communication treatment the students increased significantly. The experimental class has a significant difference compare the control class. This happens because in the experimental class students can solve problems and explain to colleagues in their own way. Whereas in the control class, only active students can solve the proposed problems and explain to their peers. Students who are quiet or less active tend to be silent and less participating. This is corresponding with previous research that scientific communication will be better if it is experienced directly by students and if the students were given a same opportunities [42]–[44]. This needs to be considered by educators to always provide equal opportunities to students. Therefore, students will acquire the same ability one another. Educators must apply some of the best solutions to make students able to understand concepts well and have better scientific communication.

4. Conclusion
Understanding of students’ scientific concepts and communication can be improved by applying learning methods. The method applied in this study is the Thinking Aloud Pair Problem Solving (TAPPS) method and the discussion method. The Thinking Aloud Pair Problem Solving (TAPPS) method emphasizes problem solving and communication between peers, while the discussion method applied in this study emphasizes collaborative and communication. The Thinking Aloud Pair Problem Solving (TAPPS) method has better scientific understanding and communication concepts than using the discussion method.

References
[1] Kemendikbud 2013, *Permendikbud 81A Tahun 2013 Tentang Implementasi Kurikulum 2013*. Jakarta: Kementerian Pendidikan dan kebudayaan
[2] Kemendikbud 2016, *Silabus Mata Pelajaran Sekolah Menengah Atas/Madrasah Aliyah*. Jakarta: BPSDMKP-PMP
[3] M. Kholid 2013, “Problematika Pendidikan di Indonesia,” *Edu-Bio*, 4, pp. 51–57
[4] Muzakar 2014, “Kinerja Kepala Sekolah dalam Meningkatkan Mutu Lulusan pada Madrasah Tsanawiyah Negeri Meureubo,” *J. Ilm. Islam Futur.*, 4 1, pp. 110–133
[5] S. Salma 2014, “Implikasi KTSP Terhadap Peningkatan Mutu Pendidikan Di Madrasah Aliyah Alkhairaat Kota Gorontalo,” *J. Pembaharuan Pendidik. Islam (JPPI)*, 1 1, pp. 143–157
[6] G. Gunawan, A. Harjono, and S. Sutrio 2017, “Multimedia Interaktif dalam Pembelajaran Konsep Listrik bagi Calon Guru,” *J. Pendidik. Fis. dan Teknol.*, 1 1, pp. 9–14
[7] S. Zahara, A. G. Haji, and M. Syukri 2018, “Improving the Concept Understanding and Scientific Attitudes through the Implementation of Scientific Approach,” *Tadris J. Kegur. dan Ilmu Tarb.*, 3 1, pp. 55–66
[8] N. Jannah, N. Fadiawati, and L. Tania 2017, “Pengembangan E-book Interaktif Berbasis Fenomena Kehidupan Sehari-hari tentang Pemisahan Campuran,” *J. Pendidik. dan Pembelajaran Kim.*, 6 1, pp. 186–198
[9] S. Latifah *et al.* 2019 “How the Predict-Observe-Explain ( POE ) learning strategy remediates students ’ misconception on Temperature and Heat materials? How the Predict-Observe-Explore ( POE ) learning strategy remediates students ’ misconception on Temperature and Heat material,” in *Seminar Nasional Fisika (SNF) 2018*, pp. 1–6.
[10] D. Hidayati 2016, “Memudarnya Nilai Kearifan Lokal Masyarakat dalam Pengelolaan Sumber Daya Air,” *J. Kependud. Indones.*, 11 1, pp. 39–48
[11] S. Prihatiningtyas and I. A. Putra 2018, “Efektivitas Penggunaan Alat Peraga Sederhana Berbasis Pendekatan Sains Teknologi Masyarakat pada Materi Fluida Statis,” *JRKPF UAD*, 5 9, pp. 102–107
[12] A. Saregar, A. Marlina, and I. Kholid 2017, “Efektivitas Model Pembelajaran ARIAS ditinjau dari Sikap Ilmiah: Dampak terhadap Pemahaman Konsep Fluida Statis,” J. Ilm. Pendidik. Fis. Al-Biruni, 6 2, pp. 255–263  
[13] F. Syarofah, I. Wiryokusumo, and Sugito 2019, “Penerapan Metode Discovery Learning dan Ekspositori Terhadap Peningkatan Hasil Belajar PKn Siswa Kelas 7 SMP Negeri 2 dan SMP Negeri 7 Bangkalan,” J. Educ. Dev., 7 2, pp. 222–226  
[14] Widayanti, Yuberti, Irwandi, and A. Hamid 2018, “Pengembangan Lembar Kerja Praktikum Percobaan Melde Berbasis Project Based Learning,” J. Pendidik. Sains Indones., 6 1, pp. 24–31  
[15] C. Anwar et al., 2019 “Effect Size Test of Learning Model ARIAS and PBL : Concept Mastery of Temperature and Heat on Senior High School Students,” EURASIA J. Math. Sci. Technol. Educ., 15 3, pp. 1–9  
[16] A. Sianturi, T. N. Sipayung, and M. Argareta 2018, “Pengaruh Model Problem Based Learning ( PBL ) Terhadap Kemampuan Berpikir Kritis Matematis Siswa SMPN 5 Sumbul,” J. UNION Pendidik. Mat., 6 1, pp. 29–42  
[17] L. Mutakinati, I. Anwari, and K. Yoshihiseke 2018, “Analysis Of Students’ Critical Thinking Skill Of Middle School Through Stem Education Project-Based Learning,” J. Pendidik. IPA Indones., 7 1, pp. 54–65  
[18] K. A. Brugar 2019, “Inquiry By the Book : Using Children ’ s Nonfiction as Mentor Texts for Inquiry Inquiry By the Book : Using Children ’ s Nonfiction as Mentor Texts for Inquiry,” Soc. Stud., 110 4, pp. 155–160  
[19] R. Anggraeni, S. Andriani, and Y. Ad 2019, “Effect of Thinking Aloud Pair Problem Solving (TAPPS) Method with Audio Visual Media for Students â€™ Critical Thinking Ability,” Int. J. Trends Math. Educ. Res., 2 1, pp. 31–33  
[20] V. Mandailina and Mahsup 2018, “Efektivitas Pembelajaran Matematika dengan Metode Thinking Aloud Pair Problem Solving (TAPPS) Terhadap Hasil Belajar Siswa SMP Bahasa Indonesia dan Balok Kelas VIII SMP/MTs,” J. Teor. dan Apl. Mat., 2 2, pp. 144–147  
[21] Surati and Hurfi 2019, “Pengaruh Penggunaan Handout Fisika Berbasis Thinking Aloud Pair Problem Solving terhadap Hasil Belajar Siswa Kelas XI SMA N 1 Ranah Batahan Pasaman Barat,” Pillar Phys. Educ., 12 1, pp. 9–16  
[22] S. Fatimah, E. H. Sujiono, and A. Haris 2015, “Pengaruh Metode Pembelajaran Thinking Aloud Pair Problem Solving terhadap Kemampuan Pemecahan Masalah Fisika Peserta Didik Kelas XI SMAN 8 Makassar,” J. Sains dan Pendidik. Fis., 11 1, pp. 14–21  
[23] S. Husein, L. Herayanti, and Gunawan 2015, “Pengaruh Penggunaan Multimedia Interaktif terhadap Penguasaan Konsep dan Keterampilan Berfikir Kritis Siswa pada Materi Suhu dan Kalor,” J. Pendidik. Fis. dan Teknol. Univ. Mataram Progr. Stud. Pendidik. Fis., 1 1, pp. 7–10  
[24] H. Yuliani 2017, “Pembelajaran Fisika menggunakan Media Animasi Macromedia Flash-MX dan Gambar untuk Meningkatkan Pemahaman Konsep Mahasiswa,” J. Ilm. Pendidik. Fis. Al-Biruni, 6 1, p. 13  
[25] S. Linuwih and N. O. E. Sukwati 2014, “Efektivitas Model Pembelajaran Auditory Intellectually Repetition (AIR) Terhadap Pemahaman Siswa pada Konsep Energi Dalam,” J. Pendidik. Fis. Indones., 10 2, pp. 158–162  
[26] I. Barlenti, M. Hasan, and Mahidin 2017, “Pengembangan LKS Berbasis Project Based Learning untuk Meningkatkan Pemahaman Konsep,” J. Pendidik. Sains Indones., 5 1, pp. 81–86  
[27] O. Ningsih 2017, “Implementasi Model Problem Based Learning Untuk Meningkatkan Pemahaman Konsep dan Aktivitas Siswa,” J. Medives J. Math. Educ. IKIP Veteran Semarang, 1 1, pp. 25–33  
[28] N. K. D. Kusuma Dewi, P. N. Riastini, and K. Pudjawan 2017, “Pengaruh Model Pembelajaran ARIAS terhadap Pemahaman Konsep Matematika pada Siswa Kelas V SD Negeri 1
Candikusuma,” e-journal PGSD Univ. Pendidik. Ganesha, 5 2, pp. 1–10
[29] Sarwi, A. Rusilowati, and S. Khanafiyah 2013, “Implementasi Model Eksperimen Gelombang Open-Inquiry untuk Mengembangkan Keterampilan Komunikasi Ilmiah Mahasiswa Fisika,” J. Pendidik. Fis. Indones., 9, pp. 123–131
[30] Sugiarti, Susanto, and Khanafiyah 2015, “Pengaruh Model Pembelajaran Inquiry berbasis Metode Pictorial Riddle Terhadap Kemampuan Berkomunikasi Ilmiah Siswa SMP,” Unnes Phys. Educ. J., 4 3, pp. 1–10
[31] M. Sasono 2014, “Pengembangan Model Pembelajaran Kooperatif Jigsaw yang Berorientasi pada Keterampilan Komunikasi Ilmiah dalam Matakuliah Fisika Kuantum,” J. Edukasi Mat. dan Sains, 2 2, pp. 1–10
[32] W. Nurhayati, S. Wardhayani, and I. Ansori 2012, “Peningkatan Komunikasi Ilmiah Pembelajaran IPA melalui Model Kooperatif Tipe Think Talk Write,” J. Pendidik. IPA Indones., 1 1, pp. 12–25
[33] Nugroho and U. Kulsum 2014, “Penerapan Model Pembelajaran Cooperative Problem Solving untuk Meningkatkan Pemahaman Konsep dan Komunikasi Ilmiah Siswa pada Mata Pelajaran Fisika,” Unnes Phys. Educ. J., 3 2
[34] C. Anwar 2017, “The Effectiveness of Problem Based Learning Integrated With Islamic Values Based on ICT on Higher Order Thinking Skill and Students’ Character,” Al-Talim J., 23 3, p. 224
[35] T. Hardianti and H. Kuswanto 2017, “Difference among Levels of Inquiry: Process Skills Improvement at Senior High School in Indonesia,” Int. J. Instr., 10 2, pp. 119–130
[36] R. R. Hake 2001, “Suggestion for Administering and Reporting Pre/Post Diagnostic Test,” http://physics.indiana.edu/~hake
[37] R. M. Indrawati 2013, “Peningkatan Aktivitas dan Hasil Belajar Materi Peristiwa Sekitar Proklamasi Melalui Bermain Peran,” J. Elem. Educ., 2 4, pp. 15–22
[38] K. Soemarmi 2017, “Upaya Meningkatkan Kemampuan Berbicara Bahasa Jepang melalui Metode Bermain Peran (Role Play),” BRILLIANT J. Ris. dan Konseptual, 2 2, pp. 225–230
[39] P. Hääkkinen, S. Järvelä, K. Mäkitalo-Siegl, A. Ahonen, P. Näykki, and T. Valtonen 2017, “Preparing teacher-students for twenty-first-century learning practices (PREP 21): a framework for enhancing collaborative problem-solving and strategic learning skills,” Teach. Teach., 23 1, pp. 25–41
[40] S. Supeno, S. Subiki, and L. W. Rohma 2018, “Students’ Ability In Solving Physics Problems on Newton’s Law of Motion,” J. Ilm. Pendidik. Fis. Al-Biruni 7 1, pp. 59–70
[41] Y. Suryani, I. W. Distrikt, and A. Suyatna 2018, “The Practicality and Effectiveness of Student Worksheet Based Multiple Representation to Improve Conceptual Understanding and Students’ Problem-Solving Ability of Physics,” Int. J. Res. - GRANTHAALAYAH, 6 4, pp. 166–173
[42] E. Eppler, L. Filgueira, J. Meyer, S. Serowy, K. Link, and B. Pauk 2018, “Enhancing Scientific Communication Skills: a Real-World Simulation in a Tertiary-Level Life Science Class Using E-Learning Technology in Biomedical Literature Perception, Reflective Review Writing on a Clinical Issue, and Self and Peer Assessments,” Res. Sci. Educ.
[43] I. R. Grange and L. Retief 2018, “Action Research: Integrating Chemistry and Scientific Communication to Foster Cumulative Knowledge Building and Scientific Communication Skills,” Chem. Educ.
[44] I. Rauschenbach, R. Keddis, and D. Davis 2018, “Poster Development and Presentation to Improve Scientific Inquiry and Broaden Effective Scientific Communication Skills †,” J. Microbiol. Biol. Educ., 19 1, pp. 1–9