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Development of Learning Tools Based on the Think Pair Share Learning Model to Improve the Mathematical Metacognition and Communication Abilities of Students at Panyabungan 4 Public Middle School

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Abstrak

Penelitian ini menguji validitas, kelayakan, dan kemanjuran metode pembelajaran Think Pair Share untuk meningkatkan metakognisi dan komunikasi matematis siswa. Penelitian ini merupakan penelitian pengembangan 4-D. Penelitian ini melibatkan siswa SMP Negeri 4 Panyabungan kelas VIIIA dan VIII-B. Penelitian ini menemukan bahwa: (1) perangkat pembelajaran Think Pair Share BS, LKPD, TKMM, dan TKKM valid; (2) perangkat pembelajaran berbasis Think Pair Share praktis: perangkat dapat digunakan dengan sedikit revisi dan hasil observasi perangkat pembelajaran di kelas menunjukkan rata-rata nilai kepraktisan Trial II siswa mempunyai pre-test sebesar 20,83% dan post-test sebesar 87,50%, serta lebih dari 80% siswa menyukai perangkat pembelajaran dan 85% setiap komponen keterlibatan siswa membuktikan siswa belajar; (4) Perangkat pembelajaran berbasis Think Pair Share yang dikembangkan meningkatkan kemampuan metakognisi dan komunikasi matematis siswa masing-masing sebesar 0,54 dan 0,52.
Kata kunci: *Pengembangan Perangkat Pembelajaran, Model 4-D, Pembelajaran Think Pair Share, Kemampuan Metakognisi Matematis, Kemampuan Komunikasi Matematis.*

Abstract

This study examines the validity, feasibility, and efficacy of Think Pair Share learning methods for improving students' mathematical metacognition and communication. This is 4-D development research. This study included SMP Negeri 4 Panyabungan class VIIIA and VIII-B students. This research found that: (1) the Think Pair Share learning tools BS, LKPD, TKMM, and TKKM were valid; (2) the Think Pair Share-based learning device was practical: the device could be used with a little revision and the results of observations of the learning device in class showed that the average practical value was Trial II students had a pre-test of 20.83% and a post-test of 87.50%, and more than 80% of students liked the learning tools and 85% of each component of student involvement proved that students were learning; (4) The developed Think Pair Share-based learning tool improved students' mathematical metacognition and communication abilities by 0.54 and 0.52, respectively.
Keywords: *Learning Tool Development, 4-D Model, Think Pair Share Learning, Mathematical Metacognition Ability, Mathematical Communication Ability*

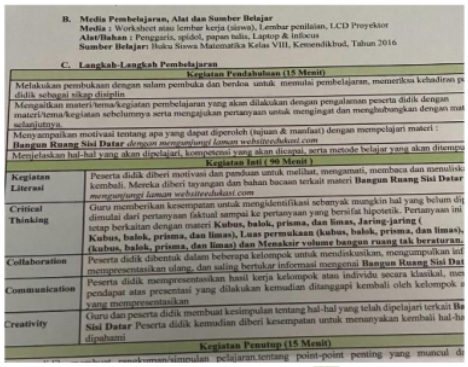
1. INTRODUCTION

Teachers must be professional in carrying out learning, especially teaching. Article 20 letter (a) of Law Number 14 of 2005 concerning Teachers and Lecturers requires teachers to develop, implement and evaluate learning outcomes. Teacher professionalism is very important for school success. Teachers supervise learning and are role models for students. The success of a learning process depends on the teacher's ability to educate, and teachers always strive to innovate learning. The approach includes learning planning, implementation, and evaluation. Study aids help with classroom teaching. Learning management tools in the classroom include learning implementation

plans, student worksheets, evaluation instruments or test results, learning media, and student guidebooks. Classroom learning relies on learning tools (Trianto, 2009:201). Learning tools help carry out effective and efficient learning to create an environment/atmosphere that allows students to learn, improve student learning outcomes, arouse students' interest in learning, provide opportunities for practice, and help students solve problems and appreciate their usefulness. Mathematics in life. Every teacher must have learning tools that influence educational success. Mathematics learning props include lesson plans, LKPD, and student books.

According to Minister of National Education Regulation no. 41 of 2007, a Learning Implementation Plan (RPP) is a learning plan that is produced in more depth referring to the syllabus to direct students' learning activities in an effort to attain basic competencies. The goal of the plan is to ensure that students graduate with the necessary skills. The RPP details the procedures that the instructor will follow during the various learning sessions. The instructor is able to manage the scenario in this way, allowing pupils to concentrate their attention on the learning that they have chosen for themselves. The RPP that is prepared needs to be comprehensive and should be able to define the conditions that will take place so that an educator can use it as a reference when they are carrying out the learning process. The truth of the matter is, however, that many educators at SMP Negeri 4 Panyabungan continue to struggle with developing appropriate lesson plans for their students.

According to the findings of interviews conducted with educators working in the field of mathematics, he continued to struggle with producing lesson plans that may raise students' interest in and desire for learning mathematics since the plans did not suit the personalities of the students. Aside from that, he also argued that LKPD was not useful in the learning process and that there was no need for it. As may be seen in the picture below.



B. **Media Pembelajaran, Alat dan Sumber Belajar**
Media : Worksheet atau lembar kerja (siswa), Lembar penilaian, LCD Proyektor
Alat/Bahan : Penggaris, apidol, papan tulis, Laptop & Infocus
Sumber Belajar: Buku Siswa Matematika Kelas VIII, Kemendikbud, Tahun 2016

C. **Langkah-Langkah Pembelajaran**

Kegiatan Pendahuluan (15 Menit)	
Melakukan pembukaan dengan salam pembuka dan berdoa untuk memulai pembelajaran, memeriksa kehadiran pe didik sebagai sikap disiplin	
Mengaitkan materi/tema/kegiatan pembelajaran yang akan dilaktukan dengan pengalaman peserta didik dengan materi/tema/kegiatan sebelumnya serta mengajukan pertanyaan untuk mengingat dan menghubungkan dengan mat selanjutnya	
Menyampaikan motivasi tentang apa yang dapat diperoleh (tujuan & manfaat) dengan mempelajari materi : **Bangun Ruang Sisi Datar** *dengan menganjungi laman websiteedukasi.com*	
Menjelaskan hal-hal yang akan dipelajari, kompetensi yang akan dicapai, serta metode belajar yang akan ditempu	
Kegiatan Inti (90 Menit)	
Kegiatan Literasi	Peserta didik diberi motivasi dan panduan untuk melihat, mengamati, membaca dan menuliskembali. Mereka diberi tayangan dan bahan bacaan terkait materi **Bangun Ruang Sisi Datar** *menganjungi laman websiteedukasi.com*
Critical Thinking	Guru memberikan kesempatan untuk mengidentifikasi sebanyak mungkin hal yang belum dipdimulai dari pertanyaan faktual sampai ke pertanyaan yang bersifat hipotetik. Pertanyaan ini tetap berkaitan dengan materi **Kubus, balok, prisma, dan limas, Jaring-jaring (Kubus, balok, prisma, dan limas), Luas permukaan (kubus, balok, prisma, dan limas), (kubus, balok, prisma, dan limas) dan Menaksir volume bangun ruang tak beraturan.**
Collaboration	Peserta didik dibentuk dalam beberapa kelompok untuk mendiskusikan, mengumpulkan inf mempresentasikan ulang, dan saling bertukar informasi mengenai **Bangun Ruang Sisi Dat**
Communication	Peserta didik mempresentasikan hasil kerja kelompok atau individu secara klasikal, mem pendapat atas presentasi yang dilakukan kemudian ditanggapi kembali oleh kelompok yang mempresentasikan
Creativity	Guru dan peserta didik membuat kesimpulan tentang hal-hal yang telah dipelajari terkait **Ba Sisi Datar** Peserta didik kemudian diberi kesempatan untuk menanyakan kembali hal-ha dipahami
Kegiatan Penutup (15 Menit)	
pengalaman/simpulan pelajaran tentang point-point penting yang muncul d	

Figure 1. RPP Used at Panyabungan 4 State Junior High School

The creation of instructional materials is essential in order to support the attainment of the learning goals that are anticipated. According to Chonga (2017:39), the application of LKPD in a manner that is suitable to the conditions of the students can lead to increased concept mastery in content that is connected to it. Student Worksheets (LKPD) are defined as printed teaching materials in the form of sheets of paper containing material, summaries, and instructions for implementing learning tasks that must be carried out by students with reference to the Basic Competencies (KD) that must be achieved (Prastowo, 2012:204). The term "Student Worksheets" is an abbreviation for "Learning Tasks That Must Be Carried Out by Students," and it is used to refer to "Student Worksheets" Student Worksheets (LKPD), which are one of the components that determine educational performance, are also factors that a teacher needs to pay attention to, and they should be required for every instructor to have.

The next item on the list are the books that students use, as books are instructional aids. It is indicated in regulation number 11 of 2005 (2003:2) written by the Ministry of National Education that textbooks are obligatory texts that must be used in classrooms and that provide subject matter in order to promote piety, character, and personality. In line with this, Trianto (2011:227) states that student books are a guide for students to use in learning activities and that they contain lesson content, investigative activities, based on concepts and activities, information, and examples of the application of lessons in everyday life. This is in keeping with the aforementioned point. The creation of quality textbooks requires meeting the criteria of both validity and effectiveness. According to Akbar (2013: 34), the following characteristics make a good textbook: (1) it is accurate (accuracy), (2) it is appropriate (relevance), (3) it is communicative, (4) it is complete and systematic, (5) it is student-centered, (6) it sides with the ideology of the nation and state, (7) the rules of the language are correct, (8) it is legible, and textbooks with high readability contain sentence length and sentence structure according to the reader's understanding.

Students who have taken mathematics are expected to have achieved graduate competency abilities, as outlined in the Graduate Competency Standards for primary and secondary education levels that are listed in Minister of Education and Culture Regulation Number 54 of 2013. These abilities include having factual, conceptual, procedural, and metacognitive knowledge. This demonstrates that metacognitive knowledge is one of the competences that students of SMP and MTS are required to attain in order to meet the requirements of the curriculum for 2013.

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A person's level of knowledge, awareness, and control over the processes and outcomes of their thought is referred to as metacognition. Metacognition is one of the cognitive processes that can have an effect on a person's ability to solve mathematical issues. However, this topic has not gotten a great deal of attention and appraisal from teachers. As a direct consequence of this, efforts to introduce metacognition in the context of the solution of mathematical problems to pupils are very deficient or tend to be neglected.

According to Livingston (1997), the term "metacognition" describes higher levels of thinking that require conscious regulation of cognitive processes during the educational process. The ability to solve issues using metacognitive strategies, particularly in mathematics, influences both the learning process and the level of performance attained by students. During the learning process, incorporating metacognition will assist students in acquiring knowledge that will be retained in their memories and understood for a longer period of time. According to Schonfeld and De Corte (Kaune, 2006: 350), it is essential to engage in metacognition in order to improve one's mathematical thinking and the processes involved in learning mathematics. In addition, Wang et al. (Kaune, 2006: 350) remark that "metacognition is in excellent rank regarding the influence on learning achievement," which indicates that metacognition plays a significant part in the process of reaching student learning outcomes. In addition, Lucangeli and Cornoldi (Desoete et al., 2001: 435), claimed that it is essential to engage in metacognition in order to get a deeper understanding of good mathematical performance.

Researchers Nasution, et al., (2021) did a study with the working title "Students' Metacognitive Analysis in Solving Integral Problems." The findings of the study revealed that the metacognition of class XII students who were studying multimedia was still considered to be in the medium category. In the meantime, Zulfikar's research (2019) shows that the four metacognitive aspects, namely: awareness aspect, cognitive strategy aspect, planning aspect, and checking aspect, received student responses on average of 2.90, 2.74, 2.95, and 2.90, and was strengthened by the results of the questions and interviews. The awareness aspect, cognitive strategy aspect, planning aspect, and checking aspect are as follows: awareness aspect, cognitive strategy aspect, planning aspect, and checking aspect. It is possible to draw the conclusion that the metacognitive strategy abilities of the students in class VIII at SMP N 16 Kupang who are able to solve mathematical problems can be categorized as belonging to the good category.

The metacognitive mathematical abilities of pupils are still rather low, according to the facts in this sector. This can be deduced from the findings of the investigations that were carried out at the SMP Negeri 4 Panyabungan campus. The diagnostic exam was given by the researchers in the form of story questions with the following material: Construct a room with level walls. The response that follows is an example of one that a student gave when working on a question from a mathematical metacognitive diagnostic examination.:

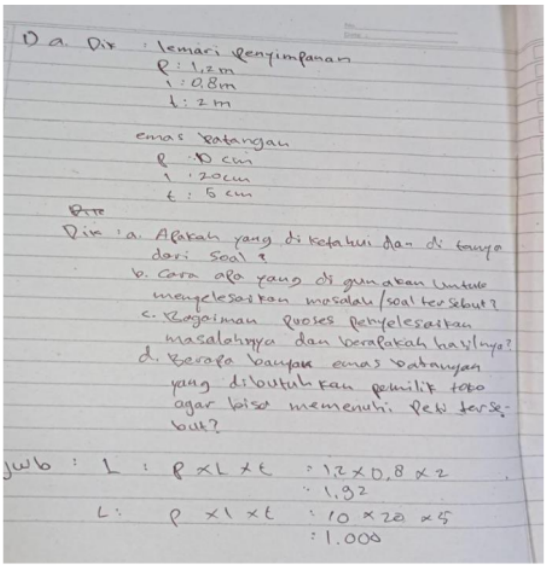

Figure 2. Student Answer Sheet for question 1

According to the findings of the students' responses, which can be found above, it can be deduced that the students were not capable of finding solutions to the mathematical metacognitive ability problems that were provided. Because students are unable to record what they know in writing and formulate inquiries in an appropriate manner, they are unable to formulate effective strategies for problem solving at this time. According to the findings of this observation, when students are asked to solve problems, they do not regulate or monitor the metacognitive processes going on in their heads, which means that they are not aware of the structures that are associated to issues concerning procedures. As a consequence of this, kids are unable to find answers to the challenges that are presented to them. It appeared that only 14 students (40%) out of the 32 students who were given diagnostic tests were able to grasp the problem, 3 students (9.38%) were able to plan problem-solving, 2 students (6.25%) were able to carry problem-solving out, and only 1 student (3.13%) was able to check again. The diagnostic exams were provided to the students by the teacher. According to the data presented above, there are still a great number of students who are unable to comprehend the issues raised in the questions, such as what is known and what is being asked. Students have a tendency to instantly construct a solution plan and carry out calculations/settlements, and as a result, students frequently make mistakes in their calculations because they do not double check the steps that they have done.

Students are expected to be able to convey mathematical concepts both verbally and in writing, in addition to having the ability to engage in metacognitive thinking. Mathematical communication skills are one of the competencies that are recommended by the National Council of Teachers of Mathematics or NCTM (2000) in the United States. This organization states that there are five basic abilities that must be learned in order to be successful in learning mathematics. These abilities are

as follows: (1) problem solving abilities; (2) communication skills; (3) connection capabilities; (4) reasoning and evidence abilities (reason and proof); and (5) representation ability. By referring to the five NCTM ability standards listed above, the mathematics learning objectives that were outlined in the curriculum that was issued by the Ministry of National Education in 2006 include, for the most part, the following: (1) connections between concepts in mathematics and their use in solving problems, (2) reasoning, (3) problem solving, (4) communication and representation, and (5) affective factors. Mathematical communication skills are referred to as strategic talents throughout both of these publications as the end goal of mathematics education. In other words, it is capable of organizing and integrating mathematical thought through speech.

According to Baroody's analysis (which can be found in Purwati, 2016), there are two primary reasons to place an emphasis on mathematical communication. The primary justification for this is that mathematics is a language that is indispensable to the study of mathematics. Mathematics is not only a tool for thinking that assists students in identifying patterns, solving problems, and providing conclusions, but it is also a tool for articulating concepts and different ideas in a way that is clear, exact, and succinct. The second reason is because teaching and learning mathematics is a social action that involves at least two people, namely teachers and pupils. This means that teaching and learning mathematics is an activity that takes place in a classroom. Students need to develop their communication skills in order to learn mathematics like a mathematician and to correctly answer problems. One crucial activity that can help them do this is talking to their friends.

As a result of the observations that were carried out at SMP Negeri 4 Panyabungan, it was determined that a large number of students were unengaged during the process of learning, which resulted in a reduction in the efficiency of the teaching and learning process. This kind of education appears to produce an environment for learning that is not yet at its most effective level. Therefore, students are not yet capable of numerically communicating with one another. despite the fact that there is mathematics content that needs pupils to verbally and written express the conclusions of their mathematical thinking to other students. Constructing a room with parallel walls is one of them.

According to Kadir (in, Hodiyanto 2017), an indicator of mathematical communication skills is the ability of students to explain ideas or situations from an image or graph given in their own words in written form (writing); state a situation with pictures or graphs (drawing); and express the situation in the form of a mathematical model (Mathematical Expression). Based on the student answer process, it turns out that students can only answer as they are so that from this indicator aspect of mathematical communication skills. Students are not yet capable of expressing the scenario in the form of a mathematical model, as demonstrated in Figure 3.

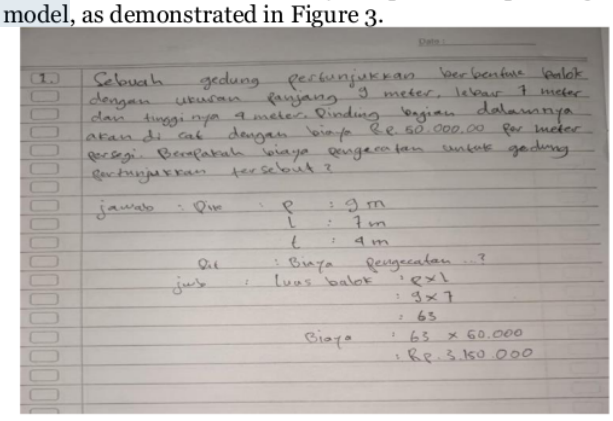

Figure 3. Student Answer Sheet for Question 2

According to the initial observations of researchers at SMP Negeri 4 Panyabungan, students' mathematical communication is still low. They explain an idea or situation from a picture or graph in their own words in written form, express a situation with a picture or graph (picture), and express the situation into a mathematical model. Many class VIII students at SMP Negeri 4 Panyabungan had difficulty solving research problems.

Mathematics learning must involve students more to strengthen their metacognitive thinking and mathematical communication skills. This can be achieved by having students actively respond to their metacognitive awareness and mathematical communication skills. Researchers believe the Think-Pair-Share (TPS) cooperative learning paradigm can improve students' metacognition and mathematical communication skills in mathematics.

Frank Lymand and Spencer Kagan designed Think Pair Share and Think Pair Square, which became the Think-Pair-Share learning approach. Lie (2008) created a think-pair-share cooperative learning framework from these two methods. Students can appreciate themselves more with this method. This strategy applies to all subjects and ages of students.

Research on cooperative learning and waiting time gave rise to the Think-Pair-Share method. Frank Lyman and his colleagues at the University of Maryland developed this method in 1985 to change student behavior in the classroom. Arend (in Trianto: 2007) said Think-Pair-Share can change class discussion patterns. If all the reading and discussion requires organization to organize the class, consider-Pair-Share can give students more time to consider, answer, respond, and help each other. Think-Pair-Share replaces whole-class questions and responses.

Based on research by Astriani and Dhana (2020) "Development of Mathematics Teaching Materials through Think-Pair-Share (TPS) learning". This research aims to produce valid and practical Think-Pair-Share (TPS) arithmetic teaching materials for class VIII students. Expert validation and valid criteria from 5 validators show the validity of the teaching material. The teacher's practicality assessment and observation of the implementation of the lesson evaluate the practicality of the product. This research creates reliable examination tools and effective mathematics teaching materials. Nopianty (2018) worked on "Metacognition-Based Teaching Materials to Improve Mathematical Communication Skills and Learning Independence for Students at SMP Negeri 30 Medan. Trial I showed that the training material improved mathematical communication skills.

In line with this, Kurnasih and Sani (2016) mentioned the benefits of the Think-Pair-Share cooperative learning paradigm, including (1) various possibilities for students to think, answer, and support each other. (2) Increasing student learning participation. (3) More opportunities to contribute for group members. (4) Easy student contact. (5) Grouping is faster and easier. (6) Students can learn from each other and discuss their ideas before presenting them in front of the class. (7) Increase self-confidence and enable all children to be involved. Students can strengthen their thinking and responding skills by interacting and helping each other in small groups.

The researcher believes that "Development of Learning Tools Based on the Think-Pair-Share Learning Model to Improve Mathematical Metacognition and Communication Skills of Students at SMP Negeri 4 Panyabungan" is relevant to the problem above.

2. METHOD

Development research will be done. The study will use Thiagarajan's 4-D development paradigm. This methodology has four stages: Define, Design, Develop, and Disseminate. This research was done on flat-sided building material at SMP Negeri 4 Panyabungan, class VIII, even semester 2022/2023. This research examined class VIII students at SMP Negeri 4 Panyabungan in 2022/2023 and

developed think-pair-share teaching materials like Teacher's Books (BG), Shiva Books (BS), Sheets Student Activities (LKPD), and metacognitive and mathematical communication tests.

This research follows Thiagarajan's 4-D learning tool creation methodology (Trianto, 2011:190). Systematic and suited for learning tool development, the 4-D model was chosen. Defining, designing, developing, and deploying comprise the 4-D model. Figure shows this research's development model schematically.:

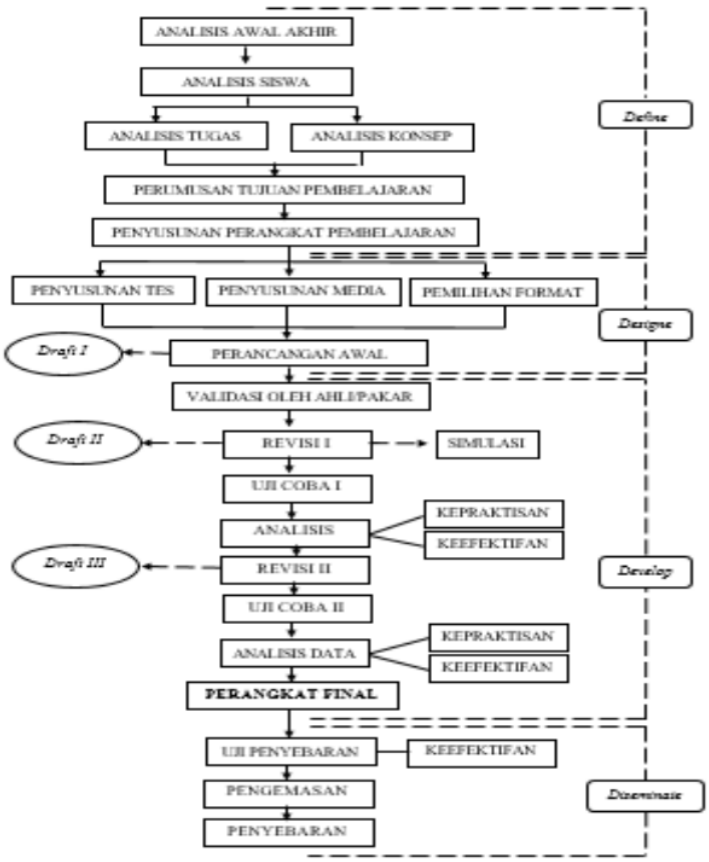

Figure 3. 4-D Model Teaching Material Development Chart

3. RESULT AND DISCUSSION

To achieve the research objectives, the researcher carried out four stages of research including: definition, design, development, and dissemination are all areas that have undergone changes as a result of the information presented in chapter III. Learning implementation plans (RPP), student activity sheets (LKPD), student books (BS), mathematical metacognitive ability tests (TKMM), and mathematical communication ability tests (TKKM) are the products of the development of learning tools. These products are the end results of the process of creating learning tools. The information obtained from the results of the validation are:

Table 1. Recapitulation of Validation Results

No	The object being assessed	Average total validation value	Validation Level
1.	Learning Implementation Plan (RPP)	4,37	Valid
2.	Student Book	4,34	Valid
3.	Student Worksheet (LKPD)	4,33	Valid
4.	Metacognitive Ability Test	4,25	Valid
5.	Mathematical Communication Ability Test	4,48	Valid

According to Table 1, the range of values for the average overall validity of educational resources is from three to four. The learning tools that were produced might be considered "Valid" if they meet the validity requirements that were established.

The research will go on to the implementation stage once it has been determined that the newly constructed learning model has satisfied the validity requirements (draft II). At the research location, which will be referred to henceforth as trial I, the learning model, which was in the form of draft II, as well as all of the learning tools, were put through their paces. The research location was class VIII of SMP Negeri 4 Panyabungan. In the event that the research success conditions were satisfied, the study was terminated. If, on the other hand, this objective has not been reached, the investigation will proceed to trial II only once the necessary enhancements have been made. When all of the planned success indicators have been met, it will be considered that the research is finished.

In this study, the level of students' mathematical aptitude is evaluated based on their mathematical metacognitive abilities using a test of mathematical metacognitive ability that was devised specifically for this purpose. The mathematics metacognitive ability test is given twice: once before the learning activity begins, which is referred to as the pre-test, and once after the learning activity is complete, which is referred to as the post-test. After receiving a learning treatment consisting of learning based on the Think Pair Share approach on Cube and Block material, the students were given a pre-test as well as a post-test so that it could be determined whether or not there was an increase in the students' mathematical metacognitive abilities as a result of the treatment. Table 2 presents the findings obtained from testing the students' mathematical metacognitive abilities in the first experiment.

Table 2. Pre-test and Post-test Completeness Levels of Students' Mathematical Metacognitive Ability in Trial I

Category	*Pretest* The number of students	Classical Completion Percentage	*Posttest* The number of students	Classical Completion Percentage
Complete	7	23,33%	20	66,67%
Not Completed	23	76,67%	10	33,33%
Amount	30	100%	30	100%

According to Table 2, it was discovered that the number of students who successfully completed the pre-test in trial I was 7 students (23.33%), while the number of students who successfully completed the post-test on their first attempt was 20 students (66.67%) and the number of students who did not successfully complete it was 10 students (33.33%).

In this study, the skill levels of students were evaluated based on their performance on tests measuring their mathematical metacognitive abilities and their mathematical

communication ability. A test that has been designed is what is going to be used in order to determine the level of the student's ability. In trial II, students' mathematical metacognitive abilities were evaluated both before and after they had completed the test, and the findings of both assessments are detailed in Table 3 below.

Table 3. Level of Pre-test and Post-test Completeness of Mathematical Metacognitive Ability in Trial II

Category	Pre-test		Post-test	
	The number of students	Classical Completion Percentage	The number of students	Classical Completion Percentage
Complete	13	43,33%	26	86,67%
Not Completed	17	56,66%	4	13,33%
Amount	30	100%	30	100%

Table 3 shows that 13 students (43.33%) completed the pre-test trial II, 17 students (56.66%) did not, and 26 students (86.67%) completed the post-test trial II.

A designed mathematical communication ability test is used to assess students' performance in this research. The mathematics communication ability test is given twice: before the lecture and afterward. The pre-test and post-test measure students' mathematics communication skills after learning using the Think Pair Share technique on Cube and Block material. Table 4 shows students' mathematical communication skills in trial I.

Table 4. Level of Pre-test and Post-test Completeness of Students' Mathematical Communication Skills in Trial I

Category	Pre-test		Post-test	
	The number of students	Classical Completion Percentage	The number of students	Classical Completion Percentage
Complete	9	30,00%	19	63,33%
Not Completed	21	70,00%	11	36,67%
Amount	30	100%	30	100%

Table 4 shows that 9 students (30.00%) completed the pre-test of trial I, 21 students (70.00%) did not, and 19 students (63.33%) completed the post-test.

Student capacity to assess mathematical communication skills is measured in this study. A designed test measures student abilities. Table 5 shows trial II students' average pre- and post-test mathematical communication scores.

Table 5. Pre-test and Post-test Completion Levels for Mathematical Communication Skills in Trial II

Category	Pre-test		Post-test	
	The number of students	Classical Completion Percentage	The number of students	Classical Completion Percentage
Complete	12	40,00%	27	90,00%
Not Completed	18	60,00%	3	10,00%
Amount	30	100%	30	100%

Table 5 shows that 12 students (40.00%) completed the pre-test trial II, 18 students (60.00%) did not, and 27 students (90.00%) completed the post-test trial II.

DISCUSSION

Student Books and LKPD are research-developed learning materials. This research aims to create a learning tool that improves students' mathematics metacognition and communication. Learning tools are evaluated for validity, practicality, and efficacy.

The validity test was used to identify flaws in the initial draft of the learning tools, which addressed Class VIII of SMP Negeri 4 Panyabungan issues relating to basic skills, material, sample questions, and practice questions. Five professionals (validators) developed this instrument. The five validators found Student Books and Student Worksheets (LKPD) legitimate and usable with minor changes. The five validators also found the students' mathematical metacognitive and communicative ability tests valid, with an average LKPD total validity of 4.33 and the Student Book of 4.34. After testing the mathematical metacognitive ability test on pretest and posttest questions from courses outside the sample, the test was valid. This was also found in the instrument reliability test. Post-test mathematical metacognitive ability was 0.830 and dependability was 0.818 (very high category). Math communication ability test reliability was 0.94 (very high). The analysis above shows that think pair share learning tools meet expert/practitioner validity standards.

Several reasons led to valid learning tools, including: The think pair share learning tools were content-valid first. This means that think pair share learning tools meet curriculum requirements. These curriculum expectations relate to fundamental competencies and basic competencies that students must attain in learning activities matched to the course content and think pair share learning phases. According to Arikunto (2009:57), a learning tool is content-valid if it can measure particular objectives that match the classes' content. Many call this content validity curricular validity.

Second, consider pair share learning tools have construct validity. It follows the principles and signs of mathematical metacognitive abilities and mathematical communication skills when developing think pair share learning aids. The learning tools support student books and LKPD, which use the think pair share approach to assess students' mathematical metacognitive and communication skills. Akbar (2013: 152) highlighted that learning tool validation tests yielded good validity.

Wirdaningsih research supports the above results and perspectives. Wirdaningsih (2019) stated that a learning tool is valid if the expert assessment reveals that it is founded on a strong theory and has internal consistency, meaning that its components are interconnected. Siregar's (2022) research also showed that the learning tools developed met minimum good requirements. Therefore, the learning tools developed meet the valid criteria.

Implementation of learning utilizing the learning tools produced is reviewed from three perspectives: learning steps, social system, and management reaction principles with support system. Trial I learning tools had unsatisfactory average scores for observing learning implementation. Learning in this class took 3 meetings and averaged 2.93 (category "not well implemented"), failing to meet the practicality of learning tools in terms of learning implementation.

Trial I's learning gadget failed practicality tests. Trial II is the following step, focusing on practical aspects that were not met. Trial II was successful in meeting learning tool practicality criteria with an average score of 3.62 (category "well implemented"). Situngkir and Napitupulu (2018) found that learning tools are practical if their average learning implementation score is good. Situngkir and Napitupulu found that the observation score of learning implementation in trial I was bad, whereas in trial II it was good, indicating the practicality of the learning tools. Based on this investigation, the learning gadget is practical as planned. This makes the learning tools useful for teachers and students.

The efficiency of learning tools is evaluated in two ways: Completeness of classical student learning Complete Classical Student Learning
The posttest study of trial I and trial II showed that trial I's mathematical metacognitive abilities did not match classical completeness standards. Students' mathematics metacognitive abilities are examined through essay assessments to determine learning completion. In trial I, students' average problem-solving skill was 79.17%, whereas in trial II, it was 87.50%, meeting classical student learning outcomes' completeness criterion. To ensure learning targets are met, Trianto (2011) suggests that at least 80% of students who take the problem solving ability test score ≥75. Post-test results of pupils' problem-solving abilities meet classical completeness.

4. CONCLUSION

The Think Pair Share learning model device is valid. The Think Pair Share learning model gadget meets pragmatic criteria for analyzing learning implementation results. The Think Pair Share learning model device met the effectiveness criteria: (1) mathematical metacognition ability was 66.67% (20 students) and in trial II it was 86.67% (26 students); (2) mathematical communication skills were 53.33% (16 students) and in trial II they were 90.00% (27 students); and (3) the average response of students in trial I was 91.33 and in trial II it was 97.50. Students' mathematical metacognitive abilities improved in all areas. Using the normalized gain index, "medium" criteria resulted in a 0.42 rise in value in trial I and 0.52 in trial II (0.3 < N-Gain ≤ 0.7). Therefore, the Think Pair Share-based learning tool can improve students' mathematical metacognition. Students' mathematical communication has improved in every area. Based on the normalized gain index, "medium" criteria increased the value in trial I by 0.44 and in trial II by 0.44. Score: 0.54 (0.3 < N-Gain ≤ 0.7). Therefore, the Think Pair Share-based learning tool can improve students' mathematical communication skills.

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