MATHIEU
Journal of Mathematics Education and Learning

journal homepage: https://journal.ar-raniry.ac.id/index.php/mathieu

MATHEMATICAL CRITICAL THINKING ABILITY OF MIDDLE SCHOOL STUDENTS THROUGH THE THINKING ALOUD PAIR PROBLEM SOLVING LEARNING MODEL

Darwani[1], Hafriani[2], Alya Karima[3]
[1,2,3] Universitas Islam Negeri Ar-Raniry Banda Aceh, Indonesia
darwani@ar-raniry.ac.id

Artikel Info	Abstrak
	Kemampuan berpikir kritis matematika siswa Indonesia masih relatif rendah, oleh karena itu perlu solusi untuk meningkatkan kemampuan berpikir kritis matematika siswa. Salah satu solusinya adalah dengan menggunakan model pembelajaran Thinking Aloud Pair Problem Solving (TAPPS). Tujuan dari penelitian ini adalah untuk melihat peningkatan keterampilan berpikir kritis matematika siswa dengan menerapkan model pembelajaran TAPPS. Jenis penelitian ini adalah eksperimen untuk satu kelompok dengan Desain Pretest-Posttest Satu-Kelompok. Instrumen dalam penelitian ini adalah Pretest dan Posttest keterampilan berpikir kritis matematika, serta instrumen pendukungnya adalah RPP (Rencana Pelaksanaan Pembelajaran) dan LKPD (Lembar Kerja Peserta Didik). Data yang diperoleh diuji dan dianalisis menggunakan Uji T Sampel Berpasangan. Hasil penelitian menunjukkan bahwa kemampuan berpikir kritis matematika siswa kelas VIII-A meningkat. Peningkatan tersebut dibuktikan dengan uji statistik menggunakan uji t, yang menunjukkan adanya peningkatan kemampuan berpikir kritis matematika siswa SMP/MTs setelah penerapan model pembelajaran Thinking Aloud Pair Problem Solving. *Indonesian students' critical thinking abilities are still relatively low, for this reason there is a need for solutions to improve students' critical mathematical thinking abilities. By using the Thinking Aloud Pair Problem*

Solving (TAPPS) learning model. The aim of this research is to see the increase in students' mathematical critical thinking skills by implementing the TAPPS learning model. This type of research is an experiment for one group with a Pretest-Posttest One-Group Design. The instruments in this research are Pretest and Posttest mathematical critical thinking skills and the supporting instruments are RPP and LKPD. The data obtained was tested and analyzed using Paired Sample T-Test. The results showed that the mathematical critical thinking abilities of class VIII-A students increased. The improvement was proven by statistical testing using the t-test with results showing that there was an increase in the mathematical critical thinking abilities of SMP/MTs students after the Thinking Aloud Pair Problem Solving learning model was implemented.

INTRODUCTION

Mathematics is a science that plays an important role in everyday life. Life activities often involve mathematics in solving and fulfilling practical life. To fulfill these needs, the ability to think logically, reason, creatively and critically is needed (Ekawati, 2022:14). Mathematical critical thinking skills are very necessary in learning mathematics to understand and solve mathematical problems or questions that require reasoning, analysis, evaluation and interpretation of thoughts (Sulistiani, 2017: 607). Glazer stated that critical thinking in mathematics is defined as the ability to involve previous information and prove things in mathematics that are not usually considered thoughtfully. According to Faicon, there are four indicators of mathematical critical thinking abilities, namely; Interpretation, Analysis, Evaluation and Inference (Maulana, 2017:10).

The Department of National Education states that one of the standards for student graduation is the development of critical thinking. However, the results of the 2021 TIMSS survey data state that more than 95% of Indonesian students are only able to answer questions at an intermediate level, so it is said that Indonesian students' mathematical critical thinking abilities are still relatively low. This is also shown by the results of the answers from class VIII-4 students at the MTsN 2 Aceh Besar school. A total of 28 students were given critical mathematical thinking questions, namely; "It is known that points A(-3.0), B(2,-5), C(7.0). Determine point D so that ABCD forms a rhombus!" and here is one student's answer:
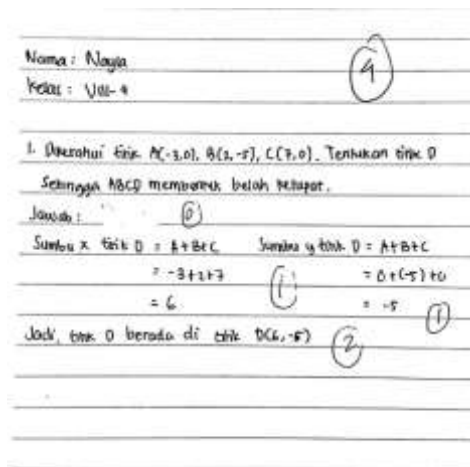
Figure 1. Student Initial Ability Test Answers

From the answer of one of the students, it can be seen that the student did not write down what was known and asked, the mathematical model created was incorrect and the conclusions drawn were incorrect. From the interview results, around 85.71% of students in that class said that they had difficulty finding the solution to the problem because they did not know how to create a mathematical model to find the coordinates of point D. And another 14.29% of students did not know which points x and y were for coordinates A, B and C even though they have been mentioned in the question and also don't know the shape of a rhombus.

To avoid this incident, it is important for teachers to pay attention to the student's learning process, one of which is paying attention to the learning model used to achieve maximum learning goals. One learning model that can be used is the Thinking Aloud Pair Problem Solving (TAPPS) learning model. The TAPPS learning model is a type of cooperative learning that can help students improve their skills in understanding, analyzing and solving problems by discussing with their group friends. The TAPPS learning model is a combination of think-aloud and teach-back techniques, with students grouped in pairs (Jonassen, 2004:139).

In this learning model, at the discussion stage students sit in pairs and each student will play a role, namely the role of Problem Solver (PSr) and Listener (L). Students who act as PSr will solve a given problem and start by reading the problem, stating assumptions, looking for strategies to solve the problem and drawing conclusions obtained after solving the problem in a loud voice. L's role is to listen in detail to what PSr explains.

David H. Jonassen stated that "TAPPS is a combination of think aloud and teachback techniques. Working in pairs, one student thinks aloud while solving any problem. Thinking aloud requires the problem solver to vocalize as many assumptions, methods, inferences or conclusions that he/she is constructing or recalling while solving a problem". This means that the TAPPS learning model is a combination of think aloud and teach-back techniques, with students grouped in pairs and this model requires students who act as problem solvers to solve the problem given by voicing as possible the assumptions, methods and conclusions that they build while solving. problems with his group friends. In this way, the learning model can develop and train students' critical thinking abilities.

RESEARCH METHOD

This research uses a quantitative approach, namely the data collection process and procedures are carried out statistically. The research design used is Pretest-Posttest One Group Design, which is a type of experimental research that uses one group to collect data. The procedure carried out is to give an initial test to a group, then the group is given a treatment, after that the group is given another test. The Pretest-Posttest One Group Design design is presented in table 1 below:

Table 1. Pretest-Posttest One Group Design

Pretest	Treatment	Posttest
O_1	X	O_2

Information:
O_1 = Prettest for experiment class
O_2 = Posttest for experiment class
X = The treatment uses the Thinking Aloud Pair Problem Solving (TAPPS) learning model

This research was carried out at the MTsS Az-Zanjabil school for three days, namely on 22, 23 and 29 May 2023. The population in this research was class VIII students at MTsS Az-Zanjabil, which consisted of four classes. The sample in this research was class VIII-A students. The sample selection was carried out using a random sampling technique. The instruments of this research are test sheets and learning tools. Class VIII-A students will be given an initial test or pretest consisting of 3 questions on mathematical critical thinking skills. Then class VIII-A students will be given treatment, namely learning that is applied using the Thinking Aloud Pair Problem Solving (TAPPS) learning model. Next, students are given another test, namely a posttest or test after being given treatment, and the questions consist of 3 questions about mathematical critical thinking skills. So there will be two data, namely pretest result data and posttest result data.

The data obtained will be in the form of ordinal scale data and to fulfill hypothesis testing using the t-test, the data must be converted into interval scale data so that the data can be processed. Changing the data scale will use MSI (Method of Successive Interval).

As a condition for testing with the t-test, the data must be normally distributed, so the data needs to be tested for data normality. The hypothesis used to test normality in this research is as follows:

$H_0 : \chi^2_{hitung} < \chi^2_{tabel} =$ The sample comes from a normally distributed population

$H_1 : \chi^2_{hitung} \geq \chi^2_{tabel} =$ The sample comes from a population that is not normally distributed

The test criteria are to reject H_0 if $\chi^2 \geq \chi^2_{(1-\alpha)(k-1)}$ and in other cases H_0 is accepted if $\chi^2 < \chi^2_{(1-\alpha)(k-1)}$ with a standard 5% ($\alpha = 0,05$) and degrees of freedom dk = k – 1. The normality test was carried out using the Chi-Square test, with the following formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Information :
χ^2 = Chi-Square distribution
O_i = Actual frequency of observation results
E_i = Expected frequency

Next, once the data is known to be normally distributed, the data will be calculated using a paired t-test with the formula:

$$t = \frac{\bar{B}}{\frac{S_B}{\sqrt{n}}}$$

Information :

$\bar{B}$ = Average difference between pretest and posttest
B = Difference between pretest and posttest
n = Number of samples
S_B = Standard deviation of B

Thus, proceed with hypothesis testing. The hypothesis tested is as follows:

$H_0 : \mu_1 = \mu_2$ Students' mathematical critical thinking abilities after applying the Thinking Aloud Pair Problem Solving learning model are the same as students' mathematical critical thinking abilities before applying the Thinking Aloud Pair Problem Solving learning model.

$H_1 : \mu_1 > \mu_2$ Students' mathematical critical thinking abilities after applying the Thinking Aloud Pair Problem Solving learning model increased compared to students' mathematical critical thinking abilities before the Thinking Aloud Pair Problem Solving learning model was applied.

The test criteria are to accept H_0 if $t_{hitung} < t_{tabel}$ with a significance 5% ($\alpha = 0{,}05$). For other t value H_0 is rejected.

To find out how much improvement has occurred, you can use N-Gain. By increasing students' critical mathematical thinking skills between before and after learning, it can be seen from calculations using the g factor formula (normalized G score), namely:

$$\text{N} - \text{gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}}$$

The N-Gain level criteria are shown in table 2 below:

Table 2. N-Gain Level Criteria

Skor *Gain*	Interpretasi
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

This research method section describes the steps to solve the problem. Describe clearly the research procedure. The method chosen should be adjusted to the type of research. For example, for classroom action research the object, time and duration of action, and location of the study can be stated. Procedures should be detailed from planning, implementing actions, observation, evaluation-reflection, which are recycling or cyclical in nature. For the experiment, it can be stated the research variables along with their operational definitions if any, the time and length of the study, the sampling technique used, the instruments used, the data analysis techniques and the research hypothesis. As for qualitative research adjusting.

RESULT AND DISCUSSION

The research was carried out at the MTsS Az-Zanjabil school located in Buket Teukueh Village, Kota Juang District, Bireuen Regency. The research was carried out in the even semester of the 2022/2023 academic year with a research period of three days, namely on 22nd, 23rd and 29th May 2023. The following is a schedule of research activities in table form:

Table 3. Schedule of Research Implementation Activities

No	Hari/Tanggal	Waktu (Menit)	Kegiatan	Kelas
1	Senin/22 Mei 2023	40	Pretest	Experiment
2	Selasa/23 Mei 2023	120	Teaching theoretical opportunity material using the TAPPS learning model	Experiment
3	Senin/29 Mei 2023	40	Posttest	Experiment

After carrying out the Random Sampling Technique, class VIII-A was obtained to carry out this research experiment and there were 18 students who were sampled. After obtaining the Pretest and Posttest data from class VIII-A, the data was obtained in the form of ordinal scale data and converted into interval scale data using MSI (Method of Successive Interval). The following data was obtained:

Table 4. Pretest and Posttest Results of Mathematical Critical Thinking Ability

No	Student Code	Pretest Scores on a Scale		Posttest Scores on a Scale	
		Ordinal	Interval	Ordinal	Interval
1	IA	1	13,12	42	31,18
2	ZR	17	26,78	31	31,89
3	NL	6	17,62	40	37,46
4	ZNH	12	21,19	27	29,03

5	NZR	13	22,85	32	32
6	SH	15	24	43	39,78
7	KN	8	19,1	32	32,33
8	DM	9	19,68	30	30,51
9	RA	20	25,76	40	37,33
10	FD	15	25,3	36	34,6
11	NT	8	19,1	39	37,05
12	KA	5	17,05	23	26,39
13	NZ	28	32,23	37	35,72
14	SE	17	25,48	34	33,7
15	AR	11	20,61	36	35,2
16	ZY	4	16,48	41	38,64
17	AZ	7	17,1	37	35,46
18	AS	14	24,96	36	34,73

Then the data was tested for normality with the Chi-Square test. The processing results tested showed that the pretest and posttest data were normally distributed. For pretest data, based on a significance level of 5% ($\alpha = 0{,}05$) with dk = k – 1 = 5 – 1 = 4 then $\chi^2_{(0,95)(4)} = 9{,}94$. The decision making criteria are; "Reject H_0 if $\chi^2 \geq \chi^2_{(1-\alpha)(k-1)}$ with $\alpha = 0{,}05$, accept H_0 if $\chi^2 < \chi^2_{(1-\alpha)(k-1)}$ with $\alpha = 0{,}05$. Because $\chi^2 < \chi^2_{(1-\alpha)(k-1)}$ is $4{,}5742 < 9{,}49$, then accept H_0 and it can be concluded that the sample comes from a normally distributed population. For posttest data, based on a significance level of 5% ($\alpha = 0{,}05$) with dk = k – 1 = 5 – 1 = 4 then $\chi^2_{(0,95)(4)} = 9{,}94$. The decision making criteria are; "Reject H_0 if $\chi^2 \geq \chi^2_{(1-\alpha)(k-1)}$ with $\alpha = 0{,}05$, accept H_0 if $\chi^2 < \chi^2_{(1-\alpha)(k-1)}$ with α =0.05. Because $\chi^2 < \chi^2_{(1-\alpha)(k-1)}$ is $2{,}7221 < 9{,}49$, then accept H_0 and it can be concluded that the sample comes from a normally distributed population.

So we can continue with hypothesis testing with the t-test. Hypothesis testing shows that the t_{tabel} value with a significant level of α=0.05 and dk = n – 1 = 18 – 1 = 17 from the t-distribution list obtained t_{tabel} of 1.740 and t_{hitung} of 9.984, which means $t_{hitung} > t_{tabel}$, namely $9{,}984 > 1{,}740$, so reject H_0 so accept H_1 which means that the Thinking Aloud Pair Problem Solving learning model can improve students' critical mathematical thinking skills significantly.

The increase in students' critical mathematical thinking skills between before and after learning with the Thinking Aloud Pair Problem Solving learning model is calculated using the g factor formula (normalized G factor), and is presented in table 5 below:

Table 5. N-Gain Results

No	Posttest	Pretest	Post - Pre	Ideal Scores	N Gain Score	N Gain Score (%)	KET
1	31,18	13,12	18,06	26,66	0,68	67,74	Medium

2	31,89	26,78	5,11	13	0,39	39,31	Medium
3	37,46	17,62	19,84	22,16	0,90	89,53	High
4	29,03	21,19	7,84	18,59	0,42	42,17	Medium
5	32	22,85	9,15	16,93	0,54	54,05	Medium
6	39,78	24	15,78	15,78	1,00	100,00	High
7	32,33	19,1	13,23	20,68	0,64	63,97	Medium
8	30,51	19,68	10,83	20,1	0,54	53,88	Medium
9	37,33	25,76	11,57	14,02	0,83	82,52	High
10	34,6	25,3	9,3	14,48	0,64	64,23	Medium
11	37,05	19,1	17,95	20,68	0,87	86,80	High
12	26,39	17,05	9,34	22,73	0,41	41,09	Medium
13	35,72	32,23	3,49	7,55	0,46	46,23	Medium
14	33,7	25,48	8,22	14,3	0,57	57,48	Medium
15	35,2	20,61	14,59	19,17	0,76	76,11	High
16	38,64	16,48	22,16	23,3	0,95	95,11	High
17	35,46	17,1	18,36	22,68	0,81	80,95	High
18	34,73	24,96	9,77	14,82	0,66	65,92	Medium
Mean	34,06	21,58	12,48	18,20	0,67	67,06	

From data processing with N-Gain, it can be seen that there are 7 students who have a high level of N-Gain, 11 students have a moderate N-Gain level and there are no students who fall into the low N-Gain category. There is an increase between the pre-test and post-test percentages in the good/very good category with the following details:

a. Interpretation rose by 51,85%
b. Analysis rose by 77,78%
c. Evaluation rose by 72,22%
d. Inference up 35,19%

Thus, from these details, it is generally shown that all aspects measured have improved. So it can be concluded that the critical thinking abilities of class VIII-A students increased after the Thinking Aloud Pair Problem Solving learning model was implemented.

CONCLUSION

The research results showed that students' critical mathematical thinking skills increased after implementing the Thinking Aloud Pair Problem Solving learning model. This is proven by calculating the percentage of pre-test and post-test results for class VIII-A students and also calculations carried out statistically using the t-test. The increase in percentage shows that the mathematical critical thinking abilities of class VIII-A students are in the good/very good category. Statistical calculations by testing hypotheses using the t-test also show an increase in mathematical critical thinking skills in class VIII-4 students. So, it can be concluded that the Thinking Aloud Pair Problem Solving learning model can improve the mathematical critical thinking skills of junior high school/MTs students.

REFERENCES

Agustianti, Rifka, dkk. *Filsafat Pendidikan Matematika*. Padang: Global Eksekutif Teknologi.

Al-Tabany, Trianto, I. B. (2014). *Mendesain Model Pembelajaran*. Jakarta: Prenadamedia Group.

Arikunto, Suharsimi. 2010. *Prosedur Penelitian*. Jakarta: Rineka Cipta.

As'ari, Abdur R., dkk. (2017). *Buku Guru Matematika*. Jakarta: Pusat Kurikulum dan Pembukuan, Balitbang, Kemendikbud.

Hassard, Jack. (2011). *Science As Inquiry.* United States of America: Jefferson Boulevard.

Hendriana, Heris, dkk. (2018). *Hard Skills dan Soft Skills Matematik Siswa*. Bandung: Refika Aditama.

Jonassen, David H. (2004). *Learning to Solve Problems.* San Francisco: Pfeiffer.

Kaniati, Mety, dkk. (2019). "Tingkat Kemampuan Berpikir Kritis Siswa dalam Menyelesaikan Soal-Soal Teks Nonfiksi". *Jurnal Ilmiah Mahasiswa Pendidikan Guru Sekolah Dasar.* 5(3): 100-111.

Lochhead, Jack dan Arthur Whimbey. (1987). "Teaching Analytical Reasioning Through Thinking Aloud Pair Problem Solving", New Directions for Teaching and Learning. 1987(30).

Maulana. (2017). *Konsep Dasar Matematika dan Pengembangan Kemampuan Berpikir Kritis-Kreatif.* Sumedang: UPI Sumedang Press.

Mulia, N. A., Hepsi N dan Novaliyosi. (2020). "Analisis Kemampuan Berpikir Kritis Matematis Siswa SMP dengan Pembelajaran Daring". *Jurnal Inovasi dan Riset Pendidikan Matematika.* 1(4): 341-352.

Sani, Fathnur. (2016). *Metodologi Penelitian Farmasi Komunitas dan Eksperimental*. Yogyakarta: Deepublish.

Sudjana. (2016). *Metoda Statistika.* Bandung: Tarsito.

Sugiyono. (2017). *Memahami Penelitian Kualitatif.* Bandung: Alfabeta.

Whimbey, Arthur, Jack Lochhead, dkk. (2013). *Problem Solving & Comprehension*. New York: Taylor and Francis.