JIPI (Jurnal IPA dan Pembelajaran IPA) 9(3), 666-682, (2025)
p_ISSN: 2614-0500 e_ISSN: 2620-553X
https://jurnal.usk.ac.id/JIPI/index https://doi.org/10.24815/jipi.v9i3.46489

Integration of Traditional Game in Problem Based Learning To Improve Critical Thinking Skills of Junior High School Students

Nasrunniati Dyahayu Anggi Winarni[1], Yayuk Mulyati[1]*, Erti Hamimi[2]

[1]Departement of Science Education, Faculty of Mathematics and Natural Sciences, State University of Malang, Jalan. Cakrawala No.5, Sumbersari, Malang 65145, Jawa Timur, Indonesia
[2]National Institute of Education, Nanyang Technological University, Nanyang 637616, Singapore

*Corresponding author's email: yayuk.mulyati.fmipa@um.ac.id

Article History:
Received date: May 30 2025
Received in revised from: August 19 2025
Accepted date: August 27 2025
Available online: September 1 2025

Citation:
Winarmi, N.D.A., Mulyati, Y., & Hamimi, E. (2025). Integration of Traditional Game in Problem Based Learning to Improve Critical Thinking Skills of Junior High School Students. *JIPI (Jurnal IPA dan Pembelajaran IPA)*, 9(3), 666–682

Abstract. The 2015 TIMSS and 2018 PISA results show that Indonesia's science performance remains below the international average and declined further in 2022. This indicates students' weak critical thinking skills (CTS) in understanding scientific concepts. An effective and interactive learning model is needed. This study aims to compare students' CTS using the traditional game in problem-based learning (TG-PBL) model and the problem-based learning (PBL) model. The research used a quasi-experimental design with a pretest-posttest non-equivalent control group and purposive sampling. Statistical tests included the paired sample t-test, independent sample t-test, and N-gain score. The independent t-test showed a significant difference between TG-PBL and PBL classes (0.000). The paired t-test showed a difference between pretest and posttest in both classes (0.000), with a greater increase in the TG-PBL class. The N-gain in the TG-PBL class was 0.57 (medium category), while in the PBL class it was 0.24 (low category). The highest improvement in the TG-PBL class was in the basic support indicator (0.630), while in the PBL class it was in strategies and tactics (0.398). The TG-PBL model is more effective in improving students' CTS. It creates a more interactive, relevant, and innovative science learning environment in junior high schools.
Keywords: Critical thinking, problem based learning, traditional game

Introduction

Critical thinking skills (CTS) are basic skills that need to be trained along with intellectual development (Bahari & Yuliani, 2021). Liu et al. (2025) stated that CTS is an educational goal that supports students' future success and helps develop their potential according to the needs of the modern world. Ennis (1985) defines critical thinking as rational and reflective thinking to support beliefs and decision making. CTS trains students to think logically, systematically, foster creative and organized thinking in solving problems (Siswati & Suratno, 2023; Kong., 2019). Students with good CTS can analyze information, think reflectively, infer knowledge, and face daily challenges (Setiawan et al., 2022; Nurissamawati et al., 2024).

The results showed that the development of CTS among Indonesian students has not produced significant results (Billah et al., 2021). The survey results according to the Trends in International Mathematics and Science Study (TIMSS) in 2015, Indonesia ranked

46th out of 51 countries with an average score of 397. This result is lower than the international average, which is 500 (Amaliya & Fathurohman, 2022). This finding is supported by the 2018 Program for International Student Assessment (PISA) results which show Indonesia's science score of 389, ranked 71 out of 79 countries, far below the average (Ismawati et al., 2023). In 2022, Indonesia's ranking rose to 70 out of 81 countries, but the average score dropped to 383. This places most Indonesian students at level 1a, a competency level where students are only able to provide basic scientific explanations in very limited contexts and require assistance with explicit information to complete scientific tasks (OECD, 2023). These low scores indicate students' difficulties in explaining scientific phenomena comprehensively (Permatasari, 2022). This difficulty is related to the low CTS, one of which is influenced by the selection of learning models that still apply direct learning that focuses on listening, observing, and recording, so that students are less active and have an impact on the low CTS (Saputra et al., 2024).

The CTS needs to be supported by a learning model that trains argument evaluation relevant to the demands of the times (Bahtiar et al., 2023). To improve it, students must practice integrating problems in learning (Sulaiman & Azizah, 2020). One of the effective models to improve CTS is problem based learning (PBL) (Anggraeni et al., 2020). This model starts learning with a problem, so students are trained in problem solving (Rahmadani & Manullang, 2024). Research by Sidampoi et al. (2024), showed that the PBL model on science material improved students' CTS, with a pretest score of 42.08 increasing to 81.66 on the posttest score. This increase is higher than the class with a conventional model, which only reached a posttest value of 65.90. The PBL model makes students active in solving real problems while encouraging them to ask questions, analyze, find solutions independently or in groups and helps students connect the concepts they have learned with real-world problems more effectively (Heong et al., 2020; Muharram & Widani, 2021).

Although effective, PBL also has weaknesses. Students with low interest in learning tend to have difficulty solving problems, are less active, and will have difficulty finding strategies or ways to solve problems (Hermansyah, 2020; Dulyapit et al., 2023) . This problem is evidenced by the results of research that shows the application of the PBL model in one school obtained a fairly wide range of posttest scores, namely 50-90. The average student posttest score is 70.71 which is still below the passing grade of 75. Of the 28 students, only 13 achieved the passing grade, so the effectiveness of PBL has not reached the maximum (Ridwan & Salsabila, 2023). Another study showed that in one application, PBL did not produce results and got a percentage of 47.06%. Learning is still less than optimal because students with low interest tend to be passive, hesitate to ask questions, and are reluctant to argue (Deracahyani, 2024).

The weaknesses of the PBL model indicate the need for a learning approach that supports understanding and active problem solving (Pristanto et al., 2024). Junior high school students tend to like games, so interactive activities can increase their activeness and learning achievement (Miftia & Widiyanti, 2023). Therefore, strategies that engage students directly in relevant tasks and encourage their participation are needed. (Rahmadani et al., 2023; Lei et al., 2022). According to Cavus et al. (2023), games can serve as an effective means to increase learner engagement and facilitate their understanding of abstract concepts. In this context, traditional games (TG) can be an effective learning method that combines elements of interaction, challenge, and active involvement of students in the learning process (Tasiah et al., 2024). Zein & Rahayu's research, (2022), showed a significant increase in student learning achievement, with the average student pretest before applying this method was 55.00, while after being given treatment with the engklek game, the posttest value increased to 85.50. However, the application of TG can cause a more crowded classroom atmosphere and requires longer preparation time (Mas et al., 2025). Therefore, a combination of strategies is needed that can optimize the advantages of TG and overcome its limitations in the learning process.

The integration between PBL and TG can create more balanced learning, where PBL helps students learn by solving life-relevant problems through systematic steps, while traditional games help increase their learning engagement and motivation. To date, research on the integration of PBL with TG is still limited, especially in the context of science learning at the junior high school level. More in-depth studies are needed to understand how the TG-PBL model can be optimally applied in science subjects, as well as the extent to which this model is able to improve students' CTS.

Methods

This study applied a quasi experiment design with a pretest-postest non-equivalent control group design. The population in this study were students from class VIII in one of the public junior high schools in Malang city, with a sample of 30 students in the TG-PBL class and 31 students in the PBL class selected using purposive sampling technique (Sundayana, 2018).

Table 1. Description of research design

Class	Pretest	Treatment	Posttest
Experiment (TG-PBL)	O_1	X_1	O_2
Control (PBL)	O_3	X_2	O_4

(Source: Abraham & Supriyati, 2022)
Description:
X_1 : Traditional game in TG-PBL model class.
X_2 : PBL model class.
O_1 : Pretest of TG-PBL class.
O_2 : Posttest of TG-PBL class.
O_3: Pretest of PBL class.
O_4: Posttest of PBL class.

This study involved two sample groups, namely a class that applied the TG-PBL model and a class that used the PBL model. Both classes applied the PBL model, but there were differences in the stages of development and presentation of results. In the TG-PBL class, students analyze case cards, answer through question cards, write answers on the student worksheet, then present the results, discuss, collect points, and provide feedback to other groups through the engklek game. Meanwhile, in the PBL class, student worksheet and at the stage of developing and presenting results, they only conduct discussions and presentations between groups without game mechanisms.

Measurement of students' CTS based on Ennis (1985) indicators, namely providing simple explanations (elementary clarification), building basic skills (basic support), inferring (inference), advanced clarification, organizing strategies and tactics. The initial data collection instrument was carried out through question validation to question expert validators, which referred to Sukardi (2014), with validity criteria referring to Sugiyono (2017). The results of validation by question expert validators obtained an average of 94% which is included in the **"Very valid"** category. Furthermore, the question instrument was tested for validity and reliability on grade XI students at one of the State Junior High Schools in Malang. The validity level refers to r_{table} (0.361) with a significance level of 0.05. In the reliability test, if cronbach's alpha > 0.60 then the item is reliable (Forester et al., 2024).

Prerequisite tests were carried out through normality tests using the Shapiro-Wilk Test and homogeneity tests using oneway anova with significance criteria > 0.05. After all data met the assumptions of the prerequisite test, hypothesis testing was carried out using independent sample t-test and paired sample t-test to analyze differences and

improvements in CTS between TG-PBL classes and PBL classes. The alternative hypothesis (H_1) for the Independent sample t-test test states that there is a difference in CTS between students in TG-PBL and PBL classes. The alternative hypothesis (H_1) for the paired sample t-test test shows that there is a difference in students' CTS before and after treatment in TG-PBL class and PBL class.

The increase in CTS was analyzed using the N-gain test, which calculates the difference between pretest and posttest scores proportionally to see the effectiveness of the treatment given. This N-gain calculation refers to equation 1 and categories according to Hake (1999).

$$< g > = \frac{X_{posttest} - X_{pretest}}{X_{maksimum} - X_{pretest}} \quad (1)$$

Table 2. N-gain categories

No.	Value $< \mathbf{g} >$	Category
1.	$(\mathbf{g}) \geq 0.7$	High
2.	$0.7 > (\mathbf{g}) \geq 0.3$	Medium
3.	$(\mathbf{g}) < 0.3$	Low

(Source: Hake, 1999)

Results and Discussion

In this section, the research data obtained through a series of data collection and analysis stages are presented. Initial analysis was conducted to test the feasibility of pretest and posttest questions as a measuring tool for CTS in one of the public junior high schools in Malang city. The validity test results show that all critical thinking indicators on the pretest and posttest have a correlation above 0.361 and significance $p < 0.05$, which means the questions are **valid**. r_{alpha} The reliability test showed a value of 0.726 on pretest data and 0.733 on posttest data, both of which were in the **high reliability** category, so the questions were suitable for use in research.

Before hypothesis testing, prerequisite tests were carried out in the form of normality tests using shapiro wilk and homogeneity tests (oneway anova). The results of the normality test showed a significance value of $p > 0.05$ so that the pretest and posttest data of both classes were normally distributed. The homogeneity test (oneway anova) obtained a significance level of $p > 0.05$ indicating that the data of the two classes were homogeneous, so that further testing could be continued.

The first hypothesis test conducted to measure the effectiveness of the learning model is independent sample t-test. The results of the independent sample t-test test are presented in Tables 3 and 4.

Table 3. Independent sample t-test results (pretest)

Category	Sample	Mean	t	Sig. (2-tailed)
TG-PBL Class	30	68.13	0.445	0.658
PBL Class	31	67		

Based on the results of the independent sample t-test test on the pretest, the significance value of $p > 0.05$ indicates that there is no significant difference between the TG-PBL class and the PBL class before learning takes place. The average pretest of TG-PBL class is 68.13 and PBL class is 67, which means that the CTS in both classes from the pretest results is low. The low pretest score is related to the lack of connection of the concepts learned in the real world which makes students' understanding limited resulting in low CTS (Azizah et al., 2023).

Table 4. Independent sample t-test results (posttest)

Category	Sample	Mean	t	Sig. (2-tailed)
TG-PBL Class	30	86.57	4.723	0.000
PBL Class	31	75.10		

The results of the independet sample t-test test showed that the posttest value of both classes was $p < 0.05$, which means H_1 accepted. From these results there is a difference between the students' CTS in the class with the TG-PBL model and the PBL model class. The TG-PBL class received an average of 86.57 while the PBL class amounted to 75.10. This shows that the TG-PBL model is able to increase the learning effectiveness in the TG-PBL class. Cavus et al. (2023) stated that games increase student participation and understanding of abstract concepts. TG make learning more interactive and involve active students (Tasiah et al., 2024). In addition, students need to get used to integrating problems in learning to develop CTS (Sulaiman & Azizah, 2020).

Paired sample t-test test on TG-PBL class and PBL class was used to see the average difference between pretest and posttest scores in each class. The results of the paired sample t-test statistical test are presented in Table 5.

Table 5. Paired sample t-test results

Class	Sample	t	df	Sig. (2-tailed)
TG-PBL Class	30	15.673	29	0.000
PBL Class	31	6.568	30	0.000

Based on Table 5, the TG-PBL class obtained a significance value of $p< 0.05$, which means there is a significant difference between the pretest and posttest results. The PBL class statistical test results obtained a significance value of $p< 0.05$, which means there is a significant difference between the pretest and posttest results, which means H_1 accepted. The calculation results show that both classes have improved. However, the combination of TG-PBL showed a more significant improvement compared to the use of PBL alone. The t value in the TG-PBL class (15.673) was greater than that of the PBL class (6.538), which showed that the improvement of the TG-PBL class was higher than that of the PBL class. This finding supports the research of Anggraeni et al. (2023) that PBL is effective in improving CTS. However, the effectiveness of PBL can be further enhanced by integrating game elements, which have the potential to increase student learning engagement and motivation (Rahmadani et al., 2023). To find out the effect of the learning model used, it can be seen further through the gain score analysis to determine the effectiveness level of each method in Table 6.

Table 6. N-Gain results of TG-PBL and PBL classes

Class	Pretest	Posttest	N-Gain	Category
TG-PBL	68.13	86.57	0.57	Medium
PBL	67	75.10	0.24	Low

Table 6, shows that the TG-PBL class achieved an N-gain of 0.57 **"medium category"**, while the PBL class only achieved an N-gain of 0.24 **"low category"**. The difference shows that learning by applying the TG-PBL model is more effective in improving students' CTS than the PBL model.

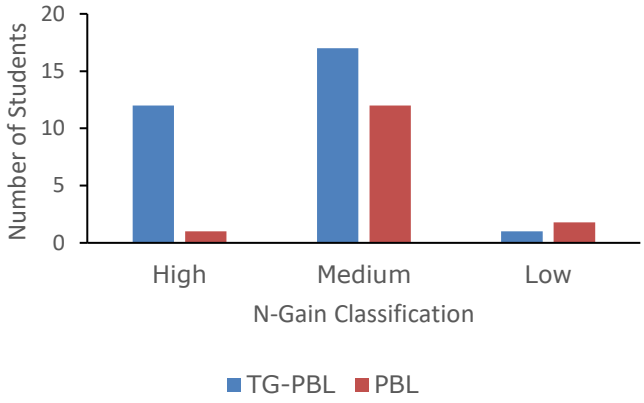


Figure 1. Student N-gain results

N-gain results showed that TG-PBL class students experienced a more significant increase compared to PBL class. This is evident from the percentage of students who reached the high category in the TG-PBL class 92% greater than the PBL class and in the low category PBL class 94% greater than the TG-PBL class.

Table 7 presents the results of the calculation of values for each critical thinking indicator. The values reflect the comparison between TG-PBL class and PBL class based on the results of pretest, posttest, and N-gain calculations.

Table 7. Calculation results of CTS indicators

Indicator	Class	Pretest	Posttest	N-gain
Elementary clarification	TG-PBL	76.4	88.7	0.521
	PBL	78.1	82	0.178
Basic support	TG-PBL	44.3	79.4	0.630
	PBL	56	68.5	0.284
Strategies and tactics	TG-PBL	73.8	85.6	0.450
	PBL	68.1	80.8	0.398
Advanced Clarification	TG-PBL	56.8	77	0.467
	PBL	61.6	64.9	0.085
Inference	TG-PBL	58.6	81	0.541
	PBL	59.1	63.9	0.140

Based on Table 7, the TG-PBL class obtained N-gain values in the medium category ($0.7 > (g) \geq 0.3$) on all indicators, while in the PBL class the N-gain values on four indicators were in the low category ($(g) < 0.3$) and one indicator was in the medium indicator. The N-gain results showed that the most trained indicator in the TG-PBL class occurred in basic support (0.630) in the medium category while in the PBL class this indicator was in the low category (0.284). In the PBL class, the most trained indicator is strategies and tactics (0.398) in the medium category, while in the TG-PBL class the strategies and tactics indicator is the indicator that has the lowest increase but with a higher value than the PBL class (0.450) in the medium category. The significant increase in basic support in the TG-PBL class is due to exploratory activities that allow students to be more active in finding information, understanding basic concepts, and participating in problem-solving-based discussions (Haddar et al., 2023). On the other hand, the improvement in strategies and tactics in PBL classes shows that this model helps students develop skills in finding information, designing strategies, and making decisions in solving problems (Rehman et

al., 2024). This is in line with the concept of CTS, which trains logical, systematic thinking, and encourages creativity and order in problem solving (Siswati & Suratno, 2023; Kong, 2019), The following analysis presents an overview of students' CTS achievement based on the comparison of N-gain criteria answers on indicators that have increased in TG-PBL classes and PBL classes, namely basic support and strategies and tactics.

Basic support

In the basic support indicator, students begin to analyze and examine the disorders experienced by patients by providing other possible causes of excretory system diseases.

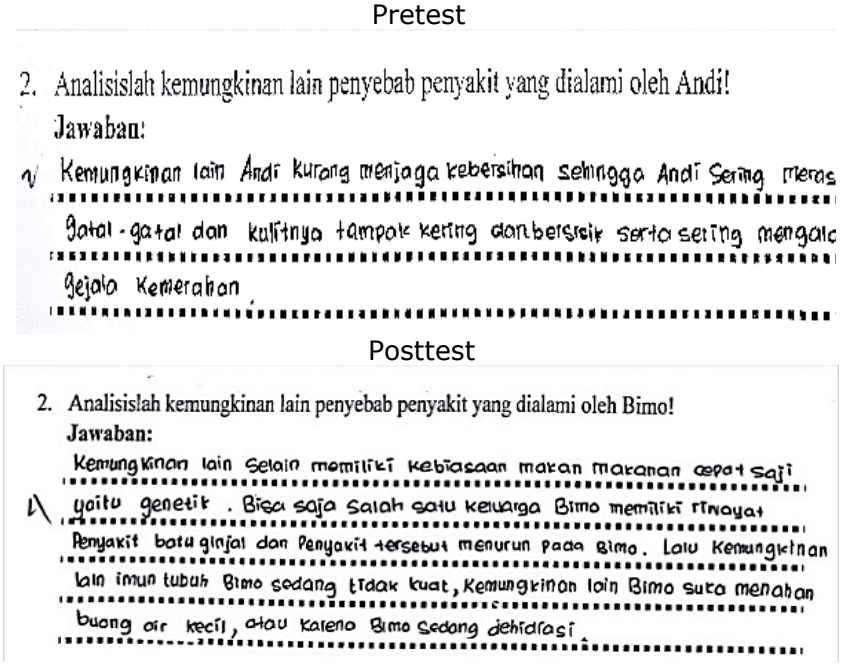


Figure 2. TG-PBL students' answers basic support indicator

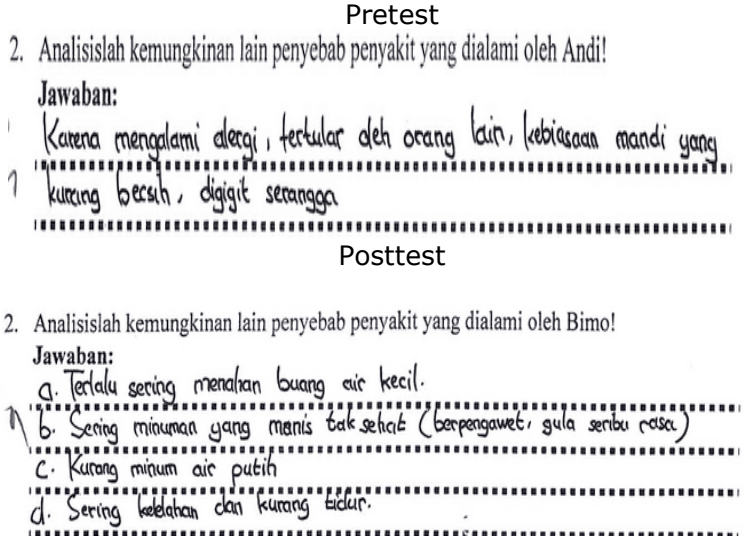


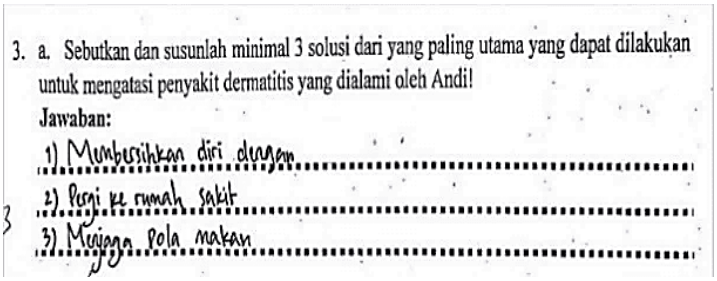
Figure 3. PBL student answers basic support indicator

In the pretest answers, both classes showed that TG-PBL class students' answers were more limited than PBL class students who were able to provide 4 answers. After learning, the posttest results showed that TG-PBL students were able to identify various possible causes more argumentatively and compare information from case analysis results. PBL class students also improved by mentioning more possibilities but their explanations were still less detailed and less supported by in-depth analysis.

Strategies and tactics

In the third indicator, namely strategies and tactics, students are given the challenge to decide on an action from the most urgent thing to do and provide steps from the selected action according to the priority scale of effective handling according to students through question items 3a and 4.

Pretest


3. a. Sebutkan dan susunlah minimal 3 solusi dari yang paling utama yang dapat dilakukan untuk mengatasi penyakit dermatitis yang dialami oleh Andi!

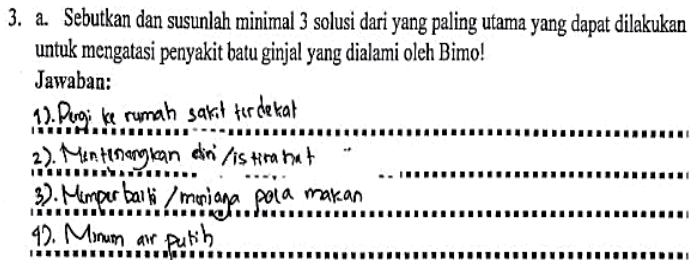
Jawaban:

1) Membersihkan diri dengan

2) Pergi ke rumah sakit

3) Menjaga pola makan

Posttest


3. a. Sebutkan dan susunlah minimal 3 solusi dari yang paling utama yang dapat dilakukan untuk mengatasi penyakit batu ginjal yang dialami oleh Bimo!

Jawaban:

1). Pergi ke rumah sakit terdekat

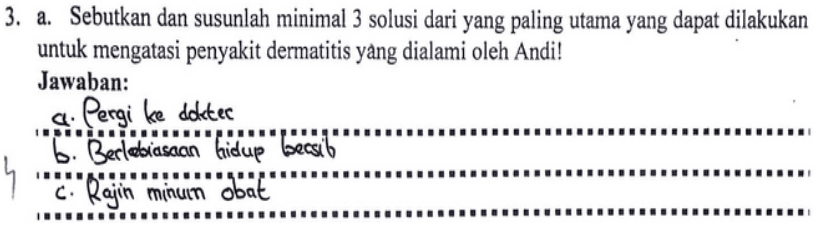
2). Menenangkan diri / istirahat

3). Memperbaiki / menjaga pola makan

4). Minum air putih

Figure 4. TG-PBL students' answers strategies and tactics indicator (3a)

Pretest


3. a. Sebutkan dan susunlah minimal 3 solusi dari yang paling utama yang dapat dilakukan untuk mengatasi penyakit dermatitis yang dialami oleh Andi!

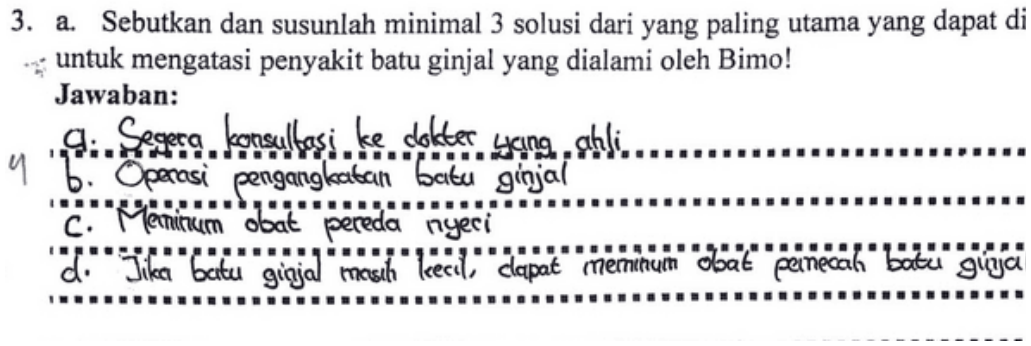
Jawaban:

a. Pergi ke dokter

b. Berlebiasaan hidup bersih

c. Rajin minum obat

Posttest


3. a. Sebutkan dan susunlah minimal 3 solusi dari yang paling utama yang dapat di untuk mengatasi penyakit batu ginjal yang dialami oleh Bimo!

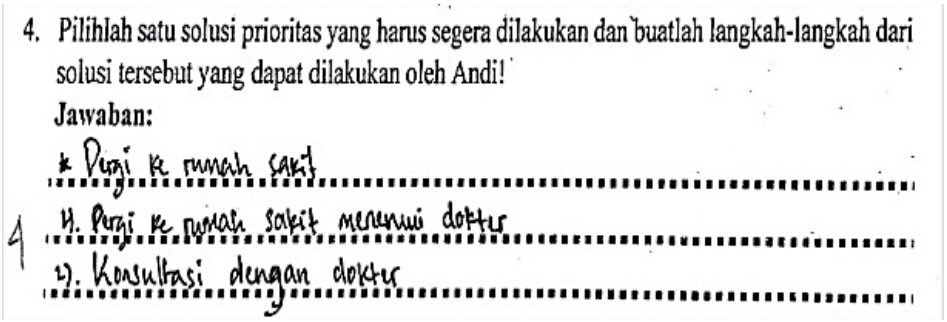
Jawaban:

a. Segera konsultasi ke dokter yang ahli
b. Operasi pengangkatan batu ginjal
c. Meminum obat pereda nyeri
d. Jika batu ginjal masih kecil, dapat meminum obat pemecah batu ginjal

Figure 5. PBL student answers strategies and tactics (3a)

In the pretest answers, TG-PBL class students were able to answer correctly but had not considered the urgency of action, while PBL class students had provided solutions with appropriate urgency. After learning, the posttest results showed that TG-PBL class students improved in determining the priority of actions based on the level of danger and medical needs of the patient, while PBL class students gave more complex and detailed answers according to the medical needs of the patient.

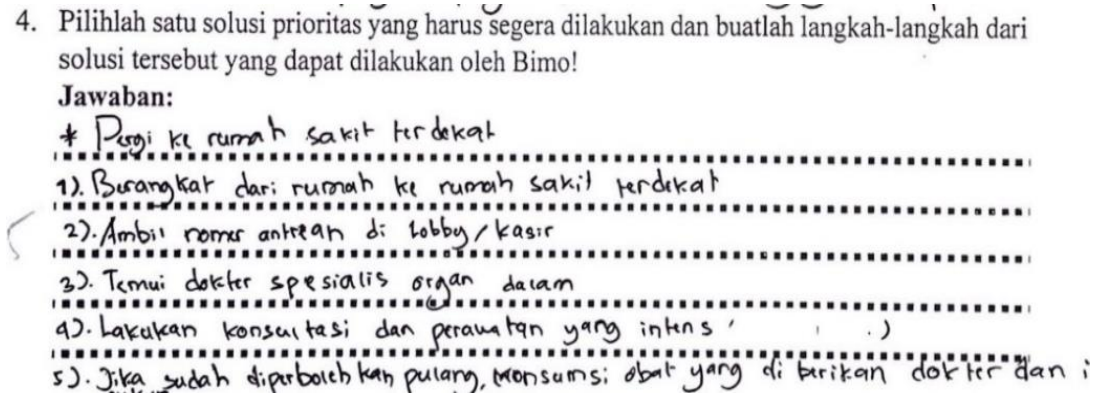
Pretest


4. Pilihlah satu solusi prioritas yang harus segera dilakukan dan buatlah langkah-langkah dari solusi tersebut yang dapat dilakukan oleh Andi!

Jawaban:

* Pergi ke rumah sakit
1). Pergi ke rumah sakit menemui dokter
2). Konsultasi dengan dokter

Posttest


4. Pilihlah satu solusi prioritas yang harus segera dilakukan dan buatlah langkah-langkah dari solusi tersebut yang dapat dilakukan oleh Bimo!

Jawaban:

* Pergi ke rumah sakit terdekat
1). Berangkat dari rumah ke rumah sakit terdekat
2). Ambil nomor antrean di lobby / kasir
3). Temui dokter spesialis organ dalam
4). Lakukan konsultasi dan perawatan yang intens
5). Jika sudah diperbolehkan pulang, konsumsi obat yang di berikan dokter dan

Figure 6. TG-PBL student answers strategies and tactics (4)

Pretest

4. Pilihlah satu solusi prioritas yang harus segera dilakukan dan buatlah langkah-langkah dari solusi tersebut yang dapat dilakukan oleh Andi!

Jawaban:

Berlebiasaan hidup bersih

- Langkah - Langkah :

1. Membersihkan rumah
2. Menggunakan air bersih
3. Makan higienis.

Posttest

4. Pilihlah satu solusi prioritas yang harus segera dilakukan dan buatlah langkah-langkah dari solusi tersebut yang dapat dilakukan oleh Bimo!

Jawaban:

Segera konsultasi ke dokter yang ahli

Langkah-langkah :

1. Pergi ke rumah sakit
2. Booking jadwal untuk konsultasi
3. Jelaskan sejujur-jujurnya kepada dokter
4. Mengikuti arahan dokter.

Figure 7. PBL student answers strategies and tactics (4)

In the pretest answers, students in both classes still mentioned the treatment steps in an unstructured and less detailed manner. After learning, the posttest results showed that TG-PBL class students were able to organize actions more systematically, consider effectiveness, and set priorities with more detailed steps. PBL class students also improved, but the improvement was still not optimal. The solution steps compiled were still less detailed, less coherent, and did not cover all aspects needed in handling the problem, so the solutions provided were still less systematic than the TG-PBL class students.

The results of the calculation and analysis of student answers show that there are significant differences between the two classes after learning. From the initial results of the pretest with the independent sample t-test, it shows that the average score of the TG-PBL class and PBL class is still low. This means that the students' CTS in both classes are still equal and classified as weak. This shows that before receiving treatment, students have difficulty explaining scientific phenomena thoroughly (Permatasari, 2022). This difficulty is influenced by the low CTS due to passive learning methods that emphasize listening, observing, and taking notes (Saputra et al., 2024). After different treatments in the second meeting, both classes showed a significant increase in CTS, with the TG-PBL class experiencing a higher increase. TG-PBL class students are more able to analyze information in depth and develop ideas to solve problems (Setiawan et al., 2022; Nurissamawati et al., 2024), while PBL class students tend to provide limited answers and have difficulty developing broader analysis. This suggests that although PBL is a learning model that focuses on developing students' CTS (Akhdinirwanto et al., 2020), its effectiveness may decrease when students are less active and not encouraged enough to explore concepts in more depth (Hermansyah, 2020; Dulyapitawati et al., 2023). This limitation is further clarified by the findings of Saputra et al. (2024) that less interactive learning causes students to tend to be passive, so that their CTS development is hampered.

In the first stage of PBL, the teacher oriented students to the problem by giving questions as a discussion starter. In the second stage, students answer the questions in the problem card with the help of student worksheet in order to explore the concept. In

the third stage, each group seeks information through group discussions to solve problems and ensure critical understanding. In the fourth stage of PBL, namely developing and presenting results, the TG-PBL model increases the effectiveness of learning. Students participate in structured games to reinforce concept understanding and apply problem-solving strategies. At this stage, students in the TG-PBL class were more organized in organizing and presenting solutions than the PBL class. Students were also more active in providing responses during the game, thus creating a more interactive learning experience (Putri et al., 2025) . The TG-PBL model has been shown to encourage students to accumulate points, which in turn increases their motivation and active engagement in the learning process (Sappile et al., 2024). The reward system in the form of points provides positive feedback to students for their achievements in learning (Wiwik, 2023). This stimulus makes students more responsive, as they naturally feel happy and more motivated when they are rewarded with points (Rusdianto, 2021). The point system makes TG-PBL class students feel challenged and more motivated to improve their understanding and present more critical solutions (Lutfi et al., 2021). According to Prastiwi et al. (2024), giving rewards creates healthy competition, increases students' confidence in presenting solutions, and encourages their involvement in learning. In the final stage of PBL, students reflect on the activities that have been carried out and get affirmation related to the material discussed.

Figure 8. stage of PBL: (a) problem orientation, (b) organizing for (c) learning,(d) guided research, developing and presenting work, (e) reflection and evaluation.

The provision of handouts in the TG-PBL class is also an important factor in improving the CTS. Handouts were given after the pretest, which was the first meeting before students entered the TG-PBL model. The material in it includes a summary of basic concepts, examples of contextual problems, and important elements of the excretory system. Although not used directly when working on the LKPD, the handout provides cognitive reinforcement that makes students more prepared and directed in finding solutions. As a result, TG-PBL students showed more ability in identifying problems, developing arguments, and drawing conclusions logically (Raya et al., 2024; Hidayati & Hakim, 2020).

The implementation of TG-PBL supports the improvement of students' CTS by creating different and more interesting learning experiences for learners and PBL makes students trained in critical problem solving (Rahmadani & Manullang, 2024; Istiqomah et al., 2021). The addition of games motivates students to learn new concepts and stay engaged in the learning process (Chans & Portuguez, 2021). With the TG-PBL model, it encourages students to solve real problems contextually, more actively ask questions, analyze, and find solutions both independently and in groups, so that their CTS is growing (Nasution et al., 2018; Muharram & Widani, 2021). The increase in CTS in the TG-PBL class is in accordance with Ennis' (1985) view, which calls critical thinking a rational and reflective thinking process to support beliefs and decision making. Students who have this ability can analyze information, think deeply, conclude, and solve problems in everyday life (Setiawan et al., 2022). This suggests the application of the TG-PBL model helps students develop higher-order thinking skills that are important in learning.

This study is limited to one school with a small sample, so the results are not representative of the wider population. In addition, individual factors such as learning style, interest, and student understanding have not been analyzed in depth, so their influence on the effectiveness of the learning model cannot be identified completely.

Conclusion

Based on the results of the study, it can be concluded that the class by applying TG-PBL experienced a higher increase in CTS than the class that applied PBL without additional media. The independent sample t-test results also showed significant differences between TG-PBL and PBL classes ($p < 0.05$). Paired sample t-test results showed significant improvement in CTS in both classes ($p < 0.05$), with greater improvement in the TG-PBL class with a t-value (15.673) greater than the PBL class (6.568). Based on the N-gain score, the TG-PBL class experienced an increase in CTS with a medium category (0.57), while the PBL class only reached the low category (0.24). The integration of TG in PBL increases students' CTS, while making learning more interactive and contextual. TG-PBL can be an alternative science learning model in junior high school, because it not only sharpens students' CTS, but also creates a learning experience that is more meaningful, collaborative, and relevant to real life. Future research can test the effectiveness of the TG-PBL model on a larger scale by involving game variations to assess its impact on student learning outcomes. In addition, in-depth analysis of individual student factors, such as learning style, motivation, and initial ability, is needed to understand the influence of this model on various student characters.

Acknowledgement

This research was funded by the Universitas Negeri Malang (UM) through a research grant under contract number 24.2.742/UN32.14.1/LT/2025. The authors would like to express their gratitude for the support provided.

References

Abraham, I., & Supriyati, Y. (2022). Desain Kuasi Eksperimen Dalam Pendidikan: Literatur Review [Quasi-Experimental Designs in Education: Literature Review]. *Jurnal Ilmiah Mandala Education*, 8(3), 2476–2482. https://doi.org/10.58258/jime.v8i3.3800

Amaliya, I., & Fathurohman, I. (2022). Analisis Kemampuan Literasi Matematika Ditinjau dari Gaya Belajar Siswa Sekolah Dasar [Analysis of Mathematical Literacy Skills Viewed from the Learning Styles of Elementary School Students]. *Jurnal Riset Pendidikan Dasar*, 5(1), 45–56. https://doi.org/https://doi.org/10.26618/jrpd.v5i1.7294

Akhdinirwanto, R.W., Agustini, R., & Jatmiko, B. (2020). Problem-Based Learning with Argumentation as a Hypothetical Model to Increase the Critical Thinking Skills for Junior High School Students. *Jurnal Pendidikan IPA Indonesia,* 9(3), 340–350. https://doi.org/10.15294/jpii.v9i3.19282

Anggraeni, D.M., Prahani, B.K., Suprapto, N., Shofiyah, N., & Jatmiko, B. (2023). Systematic Review of Problem Based Learning Research in Fostering Critical Thinking Skills. *Thinking Skills and Creativity*, 49(May), 101334. https://doi.org/10.1016/j.tsc.2023.101334

Apit, D., Supriatna, Y., & Sumirat, F. (2023). Application of the Problem Based Learning (PBL) Model to Improve Student Learning Outcomes in Class V at UPTD SD Negeri Tapos 5, Depok City. *Journal of Insan Mulia Education*, 1(1), 31–37. https://doi.org/10.59923/joinme.v1i1.10

Azizah, H., Sukarno, S., & Hartoyo, Z. (2023). Korelasi Antara Keterampilan Proses Sains dengan Literasi Sains Siswa Madrasah Tsanawiyah Negeri Kota Jambi [Correlation Between Science Process Skills and Scientific Literacy of Students at Jambi City State Islamic Junior High School]. *Physics and Science Education Journal (PSEJ)*, 3(1), 1–9. https://doi.org/10.30631/psej.v3i1.1705

Bahari, F., & Yuliani. (2021). Pengembangan Permainan Ular Tangga pada Materi Pertumbuhan dan Perkembangan untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas XII SMA [Development of the Snakes and Ladders Game on the Material of Growth and Development to Train the Critical Thinking Skills of Class XII High School Students]. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 10(3), 617–626. https://doi.org/10.26740/bioedu.v10n3.p617-626

Bahtiar, M., Maimun, I., & Ibrahim. (2023). Analysis of Collaboration, Communication, Critical Thinking, and Creative Thinking Ability of Students in Solving Science Problems in Terms of Gender. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(2), 234-245. http://dx.doi.org/10.24815/jpsi.v11i2.29065

Billah, A., Masykuri, M., & Sarwanto. (2021). Analysis of Critical Thinking in Junior High School Students Through Science Learning in Indonesia: A Systematic Review. *IOP Conference Series: Earth and Environmental Science,* 1796(1), 1-9. https://doi.org/10.1088/1742-6596/1796/1/012013

Cavus, N., Ibrahim, I., Okonkwo, M.O., Ayansina, N.B., & Modupeola, T. (2023). The Effects of Gamification in Education: A Systematic Literature Review. *Brain Broad Research in Artificial Intelligence and Neuroscience*, 14(2), 211–241. http://dx.doi.org/10.18662/brain/14.2/452

Chans, G.M., & Portuguez, C.M. (2021). Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. *Computers*, 10(10), 132. https://doi.org/10.3390/computers10100132

Deracahyani, W.O.M. (2024). Penerapan Model Problem Based Learning (PBL) Guna Meningkatkan Keaktifan dan Kompetensi Siswa pada Mata Pelajaran IPA Kelas VIIPAi SMP Negeri 3 Sungguminasa [Implementation of the Problem Based Learning (PBL) Model to Increase Student Activeness and Competence in Science Subjects in Class VIIPAi of SMP Negeri 3 Sungguminasa]. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, 6(2), 1281-1287.

Ennis, R.H. (1985). A Logical Basis for Measuring Critical Thinking Skills. *Educational Leadership*, 43(2), 44–48.

Forester, B.J., Idris, A., Khater, A., Afgani, M.W., & Isnaini, M. (2024). Penelitian Kuantitatif: Uji Reliabilitas [Quantitative Research: Data Reliability Test]. *Edu Society: Jurnal Pendidikan, Ilmu Sosial, dan Pengabdian Kepada Masyarakat,* 4(3), 1812–1820. https://www.researchgate.net/publication/382116262_Uji_Validitas_dan_Uji_Reliabilitas_Pada_Data_Penelitian_Kuantitatif

Giawa, E.F. (2024). Implementasi Model Pembelajaran Inkuiri Berbantuan Handout Bergambar untuk Meningkatkan Hasil Belajar Siswa pada Pembelajaran Biologi Kelas IX SMP Negeri 1 Amandraya [Implementation of the Inquiry Learning Model Assisted By Illustrated Handouts to Improve Student Learning Outcomes in Biology Learning for Class IX of SMP Negeri 1 Amandraya]. *Faguru: Jurnal Ilmiah Mahasiswa Keguruan*, 3(1), 90–102. https://doi.org/10.57094/faguru.v3i1.1282

Haddar, G.A.H., Hendriyanto, D., Munandar, H., Kelibia, M.U., & Muhammadiah, M.U. (2023). Analysis of the Effectiveness of Project Steam-Based Learning Model to Improve Students'critical Thinking Skills. *Community Development Journal: Jurnal Pengabdian Masyarakat*, 4(5), 10519-10525.

Hake, R.R. (1999). Analyzing Change/Gain Scores. American Educational Research Asscіation's Division D, *Measurement and Research Mhetodology*, 1, 1-4.

Heong, Y.M., Hamdan, N., Ching, K.B., Kiong, T.T., & Azid, N. (2020). Development of Integrated Creative and Critical Thinking Module in Problem-Based Learning to Solve Problems. *International Journal of Scientific and Technology Research,* 9(3), 6567–6571. https://www.ijstr.org/final-print/mar2020/Development-Of-Integrated-Creative-And-Critical-Thinking-Module-In-Problem-based-Learning-To-Solve-Problems.pdf

Hermansyah. (2020). Problem Based Learning in Indonesian Learning. *Social,Humanities, and Educations Studies (SHEs): Conference Series*, 3(3), 2257–2262. https://jurnal.uns.ac.id/shes

Hidayati, N., & Hakim, L. (2020). The Effectiveness of Handouts to Support Students' Critical Thinking Skills. *Jurnal Pendidikan Sains*, 8(2), 144–150. http://dx.doi.org/10.21070/sej.v6i2.1624

Ismawati, E., Hersulastuti, Amertawengrum, I.P., & Anindita, K.A. (2023). Portrait of Education in indonesia: Learning from PISA Results 2015 to Present. *International Journal of Learning, Teaching and Educational Research*, 22(1), 321–340. https://doi.org/10.26803/ijlter.22.1.18

Kong, S.-C. (2019). Components and Methods of Evaluating Computational Thinking for Fostering Creative Problem-Solvers in Senior Primary School Education. *Computational Thinking Education*, pp.119–141. Singapore: Springer.

Liu, W., Liu, B., Chen, C., Han, Y., & Li, G. (2025). Analyzing Students' Critical Thinking Processes Based on Falsification Heuristic Experiment. *Thinking Skills and Creativity*, 101791. https://doi.org/10.1016/j.tsc.2025.101791

Lutfi, A., Aini, N.Q., Amalia, N., Umah, P.A., & Rukmana, M.D. (2021). Gamifikasi untuk Pendidikan: Pembelajaran Kimia yang Menyenangkan pada Masa Pandemic Covid-19. *Jurnal Pendidikan Kimia Indonesia*, 5(2), 94-101. http://dx.doi.org/10.23887/jpk.v5i2.38486

Mas, A.C.D., Bramuda, P., & Disurya, R. (2025). Pengembangan Permainan Engklek Pintar (Engpin) Sebagai Media Pembelajaran Matematika untuk Siswa Kelas IV Sekolah Dasar. *Bada a Jurnal Ilmiah Pendidikan Dasar,* 7(1), 76–88. https://doi.org/10.37216/badaa.v7i1.2052

Miftia, M.A.A., & Widiyanti, F. (2023). Penerapan Pembelajaran TGT Menggunakan Media Monopoli IPSA Terhadap Hasil Belajar Siswa SMP Materi Tata Surya. *Jurnal Tadris IPA Indonesia*, 3(1), 93-98. http://dx.doi.org/10.21154/jtii.v3i1.1573

Muharram, M.R.W., & Widani. (2021). Gamifikasi Dalam Pembelajaran Matematika Melalui Productive Struggle Sebagai Solusi Pembelajaran Selama Pandemi. *Journal of Elementary Education*, 4(2), 266–277. https://doi.org/10.22460/collase.v4i2.6999

Nasution, R., Silaban, S., & Sudrajat, A. (2018). The Influence of Problem Based Learning, Guided Inquiry Learning Models Assited by Lectora Inspire, and Scientific Attitudes to Student's Cognitive Values. *Proceedings of the 3rd Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2018)*, 200, 265–269. https://doi.org/10.2991/aisteel-18.2018.58

Nurissamawati, B., Yuniawatika, & Mas'ula, S. (2024). E-Module Development Using Problem-Based Learning Approach to Learn Data Processing in Training Students' Critical Thinking. *Jurnal Inovasi Pembelajaran,* 10(1), 62–79. https://doi.org/10.22219/jinop.v10i1.28626

OCDE. (2023). PISA 2022. *Perfiles Educativos,* 46(183), 61714. https://doi.org/10.22201/iisue.24486167e.2024.183.61714

Permatasari, N. (2022). Identifikasi Kompetensi Literasi Sains Peserta Didik pada Pelajaran Ilmu Pengetahuan Alam di SMP Negeri 43 Rejang Lebong [Identification of Students' Scientific Literacy Competencies in Natural Science Lessons at SMP Negeri 43 Rejang

Lebong]. *Jurnal Didaktika Pendidikan Dasar*, 6(1), 23–46. https://doi.org/10.26811/didaktika.v6i1.799

Prastiwi, D.P., Sundawa, D., & Muthaqin, D.I. (2024). Peran Reward dan Punishment Dalam Meningkatkan Minat Belajar Siswa pada Mata Pelajaran IPS di Kelas VIII SMP Negeri 17 Bandung [The Role of Rewards And Punishments in Increasing Students' Interest in Learning Social Studies in Class VIII of SMP Negeri 17 Bandung]. *Jurnal Ilmiah Wahana Pendidikan*, 10(9), 103-113. https://doi.org/10.5281/zenodo.11172877

Putri, R.S., Solikhah, A.I., Yustiani, I.S., Qoiriyah, M.M., Setiyani, R., & Sulistina, O. (2025). Pengembangan Domino Adventure Dengan Model Teams Games Tournament Melalui Pendekatan Design Thinking Pada Pembelajaran Perubahan Wujud Zat Kelas VIII [Domino Adventure Development with Teams Games Tournament Model Through Design Thinking Approach in Learning Changes in State of Matter for Class VIII]. *Journal of Innovation and Teacher Professionalism,* 3(3), 450-510. https://doi.org/10.17977/um084v3i32025p450-510

Rahmadani, A., Ariyanto, A., Rohmah, N.N.S., Hidayati, Y.M., & Desstya, A. (2023). Model Problem Based Learning Berbasis Media Permainan Monopoli Dalam Meningkatkan Pemahaman Siswa Sekolah Dasar [Problem Based Learning Model Based On Monopoly Game Media To Improve Elementary School Students' understanding]. *Jurnal Ilmiah Pendidikan Citra Bakti*, 10(1), 127–141. https://doi.org/10.38048/jipcb.v10i1.1415

Rahmadani, F., & Manullang, S. (2024). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kritis Matematis Siswa SMP [The Influence of The Problem-Based Learning Model on the Mathematical Critical Thinking Abilities of Junior High School students]. *Alfihris: Jurnal Inspirasi Pendidikan*, 2(4), 46-56. https://doi.org/10.59246/alfihris.v2i4.994

Rehman, N., Huang, X., Mahmood, A., AlGerafi, M. A., & Javed, S. (2024). Project-Based Learning as a Catalyst for 21st-Century Skills and Student Engagement in the Math Classroom. *Heliyon*, 10(23), e39988. https://doi.org/10.1016/j.heliyon.2024.e39988

Ridwan, Y.I., & Salsabila, S. (2023). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kritis pada Materi Ekologi [The Influence of the Problem-Based Learning Model on Critical Thinking Skills in Ecological Material]. *Diklabio: Jurnal Pendidikan dan Pembelajaran Biologi*, 7(1), 49–55. https://doi.org/10.33369/diklabio.7.1.49-55

Rusdianto, R., Alang, S., & Rahman, U. (2021). Pelaksanaan Pemberian Reward dan Punishment Dalam Pembelajaran PAI di SMA Negeri 13 Makassar. *Jurnal Inspiratif Pendidikan*, 10(2), 104-123. http://dx.doi.org/10.24252/ip.v10i2.26464

Sappile, B.I., Mahmudah, L., Gugat, R.M.D., Farlina, B.., Shofi, A., Mubarok, & Mardikawati, B. (2024). Dampak Penggunaan Pembelajaran Berbasis Game Terhadap Motivasi dan Prestasi Belajar [The Impact of Using Game-Based Learning on Motivation and Learning Achievement]*. Jurnal Review Pendidikan dan Pengajaran, 7*(1), 714–727.

Saputra, D.H., Mahariyanti, E., & Irwansah, I. (2024). Efektifivitas Pembelajaran IPA Menggunakan Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis [The Effectiveness of Science Learning Using the Problem-Based Learning Model on Critical Thinking Skills]. *Jurnal Asimilasi Pendidikan*, 2(1), 7–13. http://asimilasi.journalilmiah.org

Setiawan, T.Y., Destrinelli, D., & Wulandari, B.A. (2022). Keterampilan Berfikir Kritis pada Pembelajaran IPA Menggunakan Model Pembelajaran Radec di Sekolah Dasar : Systematic Literature Review. *Justek : Jurnal Sains dan Teknologi*, *5*(2), 133. https://doi.org/10.31764/justek.v5i2.11421

Sidampoi, T., Suriani, N.W., Harahap, F., Rogahang, M., & Rungkat, J.A. (2024). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Siswa pada Materi Sistem Ekskresi Manusia di SMP Negeri 6 Tondano [The Influence Of The Problem-Based Learning Model On Students' Critical Thinking Skills in the Human Excretory System Material at SMP Negeri 6 Tondano]. *Soscied: Journal Social, Science, and Education*, 7(2), 450-459. https://doi.org/10.32531/jsoscied.v7i2.841

Siswati, B.H., & Suratno, S. (2023). The Contribution of Cognitive Ability and Critical Thinking Skills on the Problem Solving Skills of Biology Education Profession Students Using Case Method Learning. *Biosfer: Jurnal Pendidikan Biologi*, 16(2), 419–426. https://doi.org/10.21009/biosferjpb.34633

Sugiyono, (2017). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: CV. Alfabeta.

Sukardi. (2014). Metodologi Penelitian Pendidikan: Kompetensi Dan Praktiknya [Educational Research Methodology: Competencies and practices]. Jakarta: PT Bumi Aksara.

Sulaiman, A., & Azizah, S. (2020). Problem-Based Learning To Improve Criical Thinking Alibity in Indonesia: A Systematic Literature Review. *Jurnal Pedagogik*, 7(1), 107–152. https://ejournal.unuja.ac.id/index.php/pedagogik

Sundayana, R. 2018. *Statistika Penelitian Pendidikan* [Educational Research Statistics]. Bandung: CV. Alfabeta.

Tasiah, N., Nurdjan, S., & Hisbullah. (2024). Media Pembelajaran Berbasis Permainan Tradisional Engklek untuk Mengembangkan Pemahaman Literasi Membaca Peserta Didik [Learning Media Based on Traditional Engklek Games to Develop Students' Reading Literacy Understanding]. *Judikdas: Jurnal Ilmu Pendidikan Dasar Indonesia*, 3(1), 37–46. https://doi.org/10.51574/judikdas.v3i1.927

Wiwik (2023). Pembelajaran IPAS Sekolah Dasar dalam Kurikulum Merdeka dengan Pendekatan Gamifikasi Kearifan Local [Primary School Science and Technology Learning in an Independent Curriculum with a Gamification Approach to Local Wisdom]. *Jurnal Ilmu Pendidikan,* 5*,* 74-79. https://jip.joln.org/index.php/pendidikan/article/view/127

Zein, L.R., & Rahayu, R. (2022). Pentingnya Pengaruh Permainan Tradisional Engklek Terhadap Motivasi dan Hasil Belajar Siswa SMP pada Materi Pencemaran Lingkungan [The Importance of the Influence of the Traditional Game of Hopscotch on the Motivation and Learning Outcomes of Junior High School Students on Environmental Pollution Material]. *Jurnal Pendidikan Matematika dan Sains*, 10(2), 109–114. https://doi.org/10.21831/jpms.v10i2.45531