



The Effect of Problem Based Learning (PBL) with Scaffolding on High School Students' Creative Thinking Skills

Yanti Hamdiyati*, Rahmah Nurul Aina H., Mimin Nurjhani K.

Program Studi Pendidikan Biologi, Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia

*Email: yhamdiyati@upi.edu

Article Information	ABSTRAK
Submitted: 23 – 09 – 2024 Accepted: 26 – 03 – 2025 Published: 31 – 03 – 2025	Penelitian ini dilakukan untuk mengetahui apakah terdapat perbedaan keterampilan berpikir kreatif siswa sebelum dan setelah pembelajaran berbasis masalah dengan <i>scaffolding</i> . Instrumen yang digunakan dalam penelitian ini yaitu instrumen tes keterampilan berpikir kreatif dan instrumen non-tes yang terdiri atas lembar observasi dan angket respons siswa. Hasil uji statistika menunjukkan terdapat perbedaan signifikan keterampilan berpikir kreatif setelah pembelajaran berbasis masalah dengan <i>scaffolding</i> . Hal ini juga ditunjukkan dengan nilai kenaikan pada hasil tes di kategori sedang pada kelas kontrol sebesar 53% dan pada kelas eksperimen sebesar 72% pada kategori yang sama, sehingga didapatkan nilai gain 0,33 (sedang). Selain itu terdapat respon positif terhadap pembelajaran berbasis masalah dengan <i>scaffolding</i> terlihat pada rata-rata persentase setuju pada respons siswa yaitu 84% yang termasuk kedalam kategori sangat baik Kata kunci: Keterampilan Berpikir Kreatif; PBL; <i>Scaffolding</i> .
Publisher	ABSTRACT
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang	<i>This study was conducted to determine whether there is a difference in students' creative thinking skills before and after problem-based learning with scaffolding. The instruments used in this study were a creative thinking skills test instrument and a non-test instrument consisting of an observation sheet and a student response questionnaire. The results of statistical tests showed a significant difference in creative thinking skills after problem-based learning with scaffolding. This is also indicated by the increase in test results in the moderate category in the control class by 53% and in the experimental class by 72% in the same category, resulting in a gain value of 0.33 (moderate). In addition, there was a positive response to problem-based learning with scaffolding as seen in the average percentage of agreement in student responses, namely 84%, which is included in the very good category.</i> Keywords: Creative Thinking Skills; PBL; <i>Scaffolding</i> .

Copyright ©2025, Bioeduca: Journal of Biology Education

INTRODUCTION

Current developments in science and technology also influence student learning activities. The impact of these developments is the demand for students to master 21st-century skills. Essential 21st-century skills include creativity, critical thinking, collaboration, and communication. Creative thinking skills are the ability to process thoughts to produce new and unique ideas in an effort to solve a problem (Nahar,

2023). Creative thinking skills include elaboration, fluency, elaboration, and sensitivity (Ernawati et al., 2023). The current problem is that students' abilities cannot develop because learning does not actively involve them, so the concepts presented do not remain in their memories. Based on this problem, to improve students' mastery of concepts and creative thinking skills, it is necessary to implement a student-centered learning model. One such student-centered learning model is Problem-Based Learning (PBL).

Problem-Based Learning (PBL) requires students to identify problems and then find solutions based on real-world problems (Kasuga et al., 2022). During the process of identifying problems from various perspectives, students' thinking skills develop (Sakir & Kim, 2020). Students explore problems and then relate them to existing knowledge to build new knowledge and develop their skills (Kim et al., 2019). Problem-based learning is superior to other methods in creating cooperative and interactive learning in the classroom (Putri & Simbolon, 2022). Despite its various advantages, problem-based learning has several disadvantages, namely the complexity of the learning steps and inadequate facilitators (Kim et al., 2019). The steps in problem-based learning consist of (1) understanding the problem, (2) gathering information, (3) analyzing information and developing a solution, (4) developing arguments to support the solution found, and (5) evaluating the problem-solving process. These five steps are interconnected, so if a student is unable to complete one of the steps, it will be difficult for them to move on to the next step (Kim et al., 2019). Students' difficulties in completing the learning steps can occur due to the teacher's lack of role as a facilitator. Based on a meta-analysis on the effectiveness of scaffolding by Kim et al., (2018), it was stated that more than 92% of research on problem-based learning was conducted in a class with more than 25 students, so that the teacher as a facilitator had difficulty providing different assistance to each student simultaneously. Overcoming this problem requires a learning technique that can be adapted to the conditions of a class.

Scaffolding is an interaction between students and teachers by guiding and providing adequate resources or information to solve a problem (Sg Noviana et al., 2018). One such interaction is teacher feedback to students, thereby improving student understanding (Ratanasabilla et al., 2021). Scaffolding can support problem-based learning because it can be tailored to the problems or characteristics faced by students and adapted to the characteristics of the teaching materials to improve students' creative thinking skills (Haruehansawasin & Kiattikomol, 2018). Implementing scaffolding techniques can also improve the quality of scientific arguments in students during the learning process (Yolviansyah & Hermanto, 2023). Research by Nurulsari et al. (2017) produced data showing that scaffolding techniques in physics learning effectively improve students' creative thinking skills. Problem-based learning can also improve students' creative thinking skills in biochemistry material in research conducted by Ernawati et al. (2023) at the University of Jambi. The success of problem-based learning in science learning in these studies needs to be applied to other science learning, such as biology. The

application of problem-based learning with scaffolding needs to be applied to biology material that has certain characteristics that match the character of the problem-based learning method with scaffolding.

One of the characteristics of biology material that can be applied to problem-based learning is having a real problem. This problem can be a discussion material for students so that student activeness is needed to solve the problem (Nasrullah et al., 2018). Material that allows students in Grade XI to investigate a real problem is in various organ system materials with the learning outcome 'students can analyze the relationship between organ structure in the organ system with its function as well as abnormalities or disorders that arise in the organ system'. In this learning outcome it is stated that students need to relate abnormalities/disorders that arise in the organ system or problems in the organ system with the working mechanism of the organ. Of the various organ systems studied by high school students, there is material on the nervous system that is considered abstract and difficult by students (Nurokhmah et al., 2016). This statement is supported by the situation of grade XI at Cilimus High School where 50% of students have difficulty in understanding the concept of nervous system material (Nurokhmah et al., 2016). Based on this problem, the researcher chose the nervous system material. Difficulties in understanding nervous system material can be overcome using scaffolding techniques in problem-based learning, which helps students understand nervous system disorders by simplifying the problem and explaining the complex processes involved in various nervous system disorders (Park et al., 2020). Problem-based learning with scaffolding is implemented because it can require students to think creatively and maximize learning time in formulating solutions to disorders or disorders of the nervous system.

Based on the problems mentioned previously, the researcher wants to investigate the effect of problem-based learning with scaffolding on the creative thinking skills of high school students on the Nervous System material. The purpose of this study is to determine students' creative thinking skills before and after problem-based learning with scaffolding on the nervous system material and to analyze the effect of this learning based on students' responses after the learning.

METHOD

The method used in this study was a quasi-experiment with one control class and one experimental class. The control class was a class that used problem-based learning methods without scaffolding. The experimental class was a class that used problem-based learning methods with scaffolding. Overall, there were 61 11th grade students at SMA X Bandung who participated in this study. Class selection was determined by purposive sampling with the criteria that the class studied the nervous system and had implemented the Independent Curriculum.

There are three stages to analyzing students' creative thinking skills. In the first stage, students will take a pre-test to measure their creative thinking skills before learning. The second stage is problem-based learning with scaffolding for the experimental class and problem-based learning without scaffolding for the control

class. In the second learning stage, classes will be observed to measure students' creative thinking skills using the sensitivity indicator. After learning ends, students will take a post-test to measure their creative thinking skills after learning. The tests administered to both classes are descriptive questions to measure creative thinking skills using the fluency, flexibility, and elaboration indicators developed by Torrance (2018). The sensitivity indicator for creative thinking skills is measured through observation of the learning process by observers (Ernawati et al., 2023). In addition to analyzing creative thinking skills, researchers will collect student responses to problem-based learning with scaffolding collected through a questionnaire on Google Forms after the learning is implemented.

The collected test data was then summarized and processed using SPSS version 25 software. The data tested using SPSS were test data from both classes. The statistical tests conducted began with prerequisite tests in the form of normality and homogeneity tests, followed by hypothesis testing. The hypothesis test used was the Paired T-Test if the data was normally distributed and homogeneous or the Wilcoxon Test if the data was not normally distributed and homogeneous. The collected student response data was then processed and discussed qualitatively to support other data.

RESULTS AND DISCUSSION

One step that can be taken to determine the differences in students' creative thinking skills before and after problem-based learning with scaffolding is to conduct research on predetermined participants. The results of the research conducted on both classes are shown in Table 1, as follows.

Table 1. Summary of the distribution of students' creative thinking skills test results.

Results of Students' Creative Thinking Skills Test										
Pre-test					Post-test					
Class	Interval	Category	F	(%)	Average	Interval	Category	F	(%)	Average
Experimen	0-25	Very Low	2	6	32	0-25	Very Low	0	0	61
	26-50	Low	25	78		26-50	Low	5	16	
	51-75	Good	4	13		51-75	Good	25	75	
	76-100	Very Good	1	3		76-100	Very Good	3	9	
Control	0-25	Very Low	13	45	24	0-25	Very Low	0	0	52
	26-50	Low	16	55		26-50	Low	13	45	
	51-75	Good	0	0		51-75	Good	15	52	
	76-100	Very Good	0	0		76-100	Very Good	1	3	

Creative Thinking Skills Before and After Learning

The pre-learning situation shows that the two classes have significantly different creative thinking skills. Table 1 shows that the average pre-test score for the experimental class is higher than the control class, with an average score of 41, while the control class has an average score of 24. Both classes have scores below the average passing grade for biology, which is 72. Another initial situation that can be used as supporting data in determining the effect of problem-based learning with scaffolding is the distribution of students' pre-test scores in each class. The pre-test data shows that creative thinking skills in both classes need to be improved. The data

on creative thinking skills before learning shows that the distribution in the control class is uneven, as they are only spread across two categories: poor and very poor. This is in contrast to the experimental class, which has a distribution of scores in each category ranging from very poor to very good.

The initial conditions of both classes met the ideal criteria for scaffolding because the distribution of creative thinking skill scores was mostly in the poor and very poor categories. During the research learning (Haruehansawasin & Kiattikomol, 2018) scaffolding was ideally given to students with low achievement so that the possibility of learning improvement would be maximized. Learning was carried out for two lesson hours (2x40 minutes) with material on disorders of the nervous system. Students were given problems related to disorders of the nervous system on the Student Worksheet (LKPD). The scaffolding-based learning process in the experimental class began with (1) problem orientation; (2) group discussion; (3) panel discussion with other groups; (4) scaffolding I (assistance by the teacher); (5) scaffolding II (assistance by peers); (6) elaboration; (7) analyzing and evaluating the problem-solving process (Ernawati et al., 2023). In the control class, the problem-based learning process was carried out with the following steps: (1) Problem orientation; (2) organizing students to learn; (3) conducting investigations; (4) developing and presenting results; (5) analyzing and evaluating the problem-solving process. Learning activities are carried out in groups with each group consisting of six students. The group system is necessary because in addition to problem-solving skills, creative thinking skills and collaborative learning skills are also needed (Gallagher et al., 1995). Student collaboration in groups during the learning process can foster engagement (Hmelo-Silver & Barrows, 2015). This engagement can occur and increase if the relationship between teachers and students and students within the group is of good quality (Ferrer-Caja & Weiss). High engagement will increase the likelihood of students successfully overcoming difficult problems, thereby increasing student competence (Chirkov & Ryan, 2001). Problem-based learning can also foster student independence because the teacher as a facilitator reduces his/her intervention during learning, allowing students to experience various experiences (Kim et al., 2019). Student independence can also increase because students need to make various decisions during learning (Chirkov & Ryan, 2001). Various decisions made by students will indicate the level of student sensitivity. So, during the learning process, students were observed by observers to measure sensitivity indicators in creative thinking skills. Table 2 shows the results of observations from both classes.

Table 2. Results of observations of creative thinking skills in both classes

Observation Indicators	Poin	
	Control class	Experiment class
Students respond quickly to every question or statement from the teacher.	2	3
Students conclude the main problem quickly	3	4
Students provide responses to questions or statements given by their classmates appropriately.	2	3
Students can provide assistance according to the needs of their peers..	3	4

Skor	50 (enough)	70 (good)
From the beginning of the lesson, the teacher, as a facilitator, asks questions and questions to students to identify their prior knowledge. Students gain new knowledge by identifying gaps between their current knowledge and the knowledge needed to address the presented problem (Barrows, 1996). The problem-orientation process can measure students' sensitivity by calculating the speed and accuracy of students in finding solutions and then integrating them into concepts (Ernawati et al., 2023). The experimental class received superior points compared to the control class. This superiority was due to the greater student activity in the experimental class compared to the control class. However, students in the control class also demonstrated activeness during the problem orientation because they always had the hope of being able to actively participate in producing a real solution (Wood, 2003). The steps in solving a problem include finding and understanding a problem, developing an appropriate strategy for solving the problem, dissecting the solution, and thinking about/defining the problem and long-term solutions (Santrock, 2007). Identifying and understanding a problem is the first step in solving a problem, so to proceed to the next step, this process needs to be done quickly. Based on Table 2, it can be seen that in both classes, students were able to quickly conclude the problem. Haruehansawasin & Kiattikomol (2018) found that students who received scaffolding showed better grades. This is consistent with the observation results of the experimental class, which was superior to the control class. The scaffolding process in the experimental class was carried out after students had discussions to solve problems. Scaffolding can be defined as a learning technique that focuses on building problem-solving skills by providing appropriate assistance (Wood et al., 1976). This assistance refers to assistance provided by teachers to students so they can manage and integrate information (Sg Noviana et al., 2018). This assistance can also be provided by peers after the teacher reduces their assistance. Scaffolding involves providing some assistance to students in the early stages of learning, then reducing assistance and allowing students to take over greater responsibilities (Cahyono Adi, 2010). Assistance that can be provided to students includes motivational scaffolding, conceptual scaffolding, strategic scaffolding, and metacognitive scaffolding (Collins et al., 2018). Motivational scaffolding plays a role in increasing students' interest, confidence, and collaboration skills (Tuckman & Schouwenburg, 2004). Conceptual scaffolding typically involves combining various strategies into concept maps and visual strategies, allowing students to perceive the problem as important and relatable to their experiences (Kim et al., 2019). Metacognitive and strategic assistance include assistance in breaking down problems into step-by-step solutions based on existing skills and knowledge. Metacognitive assistance includes guidance, encouragement, and reminders for understanding the material (Oliver & Hannafin, 2000). Motivational support is provided throughout the learning process to enhance learning success (Ernawati et al., 2023). The formulation of this support can be tailored to students' needs during the learning process. This relates to students' motivation and self-confidence, which		

can increase or decrease for various reasons. Therefore, various types of scaffolding should be provided according to the situation (Belland et al., 2013).

Observations continued, particularly during the discussion phase with group and classmates, until the results of the discussion were conveyed to classmates. During the presentation phase, observers measured the third and fourth indicators, which examined students' level of sensitivity to peers. In the third indicator, observers assessed students' responses to questions or statements from other students. Students in the experimental class actively responded during discussions in small groups and as a whole. This was supported by the results of student responses to the statement "I felt actively involved during discussions with group members and other classmates," which showed a percentage of 90%, categorized as very good. This is in line with research by Kim et al. (2019), which showed that assistance (scaffolding) provided by peers with equal abilities yielded better results because they could understand each other's situation. The control class also showed that some students were able to respond to questions and statements appropriately, but there were still students who were unable to share the information they had obtained with their peers. Teachers acting as facilitators stimulate students through introductory questions, encourage students to discuss, direct students to build focus, provide various sources and input, supervise the learning process, and provide support according to student needs (Greening, 1998). In problem-based learning with scaffolding, assistance is also provided by peers, the assistance provided by peers needs to be adjusted to the needs of the recipient of the information. Based on the results of observations, it shows that students in both classes can provide assistance according to the needs of their peers. According to Chachia et al., (2010) creative thinking skills are part of the learning process to help students become more confident and responsible. Student creativity can emerge well if there is a good learning environment that can facilitate students in solving problems with the right concepts (Wicaksono, 2017). Activities or environments that can produce creative thinking skills include; (1) exploring various materials widely according to their wishes; (2) creating a theory or way for students to solve problems; (3) creating student groups to share knowledge and opinions; and (4) a project that must be completed with various problem-solving activities (Rusfendi, 2006).

Comparison of Students' Creative Thinking Skills in the Control Class and the Experimental Class.

The difference in the average of two paired samples can be determined by conducting a Paired T-Test. This data analysis can be carried out if it meets the requirements, namely the data is normally distributed and homogeneous. The results of the hypothesis test in the experimental class showed a difference in creative thinking skills before and after problem-based learning. The same results were also obtained from the hypothesis test in the control class. Creative thinking skills are important in solving problems and generating innovative ideas (Salih M, 2020). The creative thinking skills test instrument contains three indicators: fluency thinking skills,

flexibility thinking skills, and elaboration thinking skills. Figure 1 contains a summary of the average test scores based on each indicator in both classes.

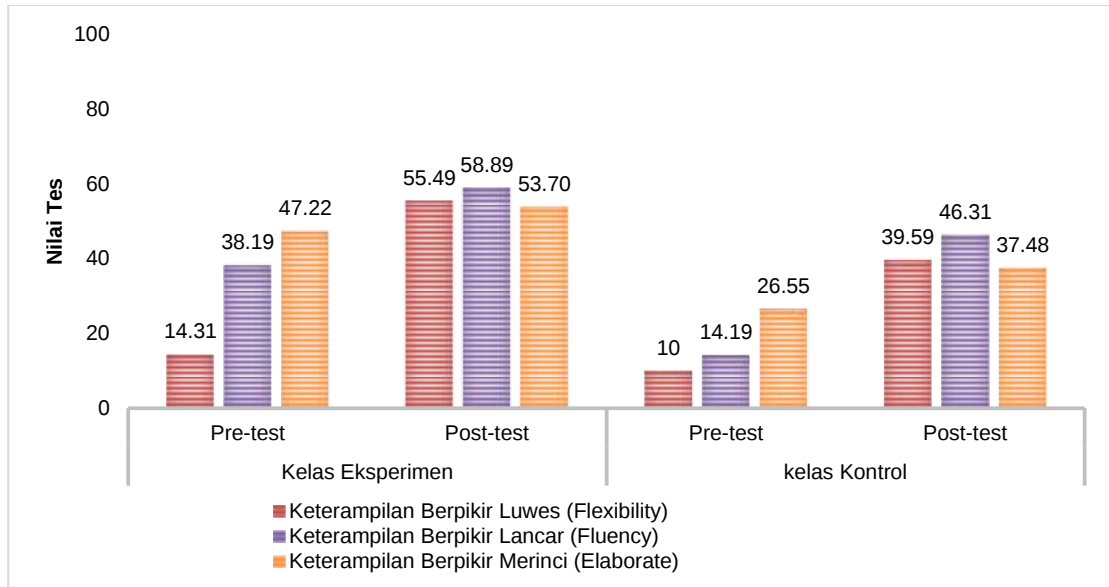


Figure 1. Average creative thinking skills score for each indicator

Fluency is one indicator of creative thinking skills. The research instrument, which used the research questions, was formulated based on research conducted by (Ernawati et al., 2023). In this study, the fluency indicator was designed to reveal students' problem-solving skills through various solutions. The fluency indicator was measured based on the number of students' answers regarding the causes and solutions to the problems presented. The problems presented concerned disorders of the nervous system, such as the increase in Alzheimer's disease cases and cases of patients with Parkinson's disease. All data showed that test scores for the fluency indicator were still below the minimum passing criteria. According to (Wahyuningsih, 2012), the nervous system is quite complex to learn because it includes abstract learning, such as the structure and mechanisms of the nervous system, which cannot be directly observed. Based on this opinion, the problems in the nervous system material also became quite complex, as seen from the average score obtained by both classes, which was below the minimum passing score, namely 72.

Flexibility is one of the indicators used to assess students' creative thinking skills. In the flexibility indicator, students are presented with a problem with a variety of different situations. These diverse situations are expected to stimulate students' creative thinking skills, allowing them to view a problem from multiple perspectives. The questions used to measure student flexibility consist of two questions involving a theory on the mechanisms of the nervous system and a person's lifestyle related to nervous system disorders. The theory used is "brain plasticity," chosen because it can be used to understand various problems in the nervous system. Brain plasticity itself is the brain's ability to change structure and function based on experience and stimuli received by the brain (Fahlevi et al., 2023). The second question to measure

student flexibility indicators asks about the influence of a person's lifestyle on nervous system disorders. This lifestyle question is less well understood by students because some students still present solutions such as taking medication, which is not a sustainable lifestyle. This obstacle may occur due to students' lack of understanding of the questions or problems presented. Research conducted by Restriani Adiwijayanti et al. (2018) stated that low scores on the flexibility indicator were due to students experiencing misconceptions in understanding the conditions of the questions or problems presented, resulting in inappropriate strategies for solving the problems. This opinion is consistent with the low test results of students in both classes.

Elaboration thinking skills are the third indicator that can be measured from creative thinking skills. In the elaboration indicator, students will be given a problem, as a follow-up to the solutions offered in the fluency question, students then detail one of the most appropriate solutions to overcome the problem. In addition to detailing the solution, students are also given information to support a problem in the form of an image that needs to be detailed into a paragraph by the students. The elaboration indicator has a very low gain value indicating that students' creative thinking skills for the elaboration indicator are difficult for students to improve. Researchers observed that there are various possibilities for this to occur, including (1) students are not yet accustomed to the questions given by the teacher; (2) misconceptions occur when students answer questions so that the answers given are not quite right; (3) the problems given by the teacher are too difficult or have never been encountered by students in their daily lives; and (4) supporting information in the form of images is not clear enough so that students have difficulty answering questions based on that information. Students have low creative thinking skills because students have not been able to use them as needed during the learning process, so it is necessary to integrate creative thinking skills with other learning (Rofiudin, 2000). Just like the flexibility indicator, students may experience misconceptions and difficulties in answering questions given by the teacher.

Student Responses to Problem-Based Learning with Scaffolding

Student responses to problem-based learning with scaffolding showed varying results. This may be because problem-based learning with scaffolding is a new experience for students. Table 3 shows an analysis of student responses in the form of percentages and categories for each student question.

Table 3. Student responses to problem-based learning with scaffolding.

Indicator	Sub Indicator	statement	Total score	Persent	Category
Student responses to problem-based learning with scaffolding	Response to assistance provided by the teacher (Scaffolding I)	P2	109	88%	Very good
		P3	109	88%	Very good
		P4	105	85%	Very good
	Response to teacher	P1	106	85%	Very good

Indicator	Sub Indicator	statement	Total score	Persent	Category
The application of problem-based learning to students and its relationship to students' creative skills	directions during learning				
	Student response to assistance provided by peers (Scaffolding II)	P5	98	79%	good
		P6	101	81%	Very good
	Student responses in formulating a problem	P7	105	86%	Very good
	Student responses in finding solutions based on the given cases	P8	107	86%	Very good
	Student responses to their performance in groups.	P9	111	90%	Very good
		P10	94	76%	good

Student response data showed good, even excellent, results based on the calculation of the total score for each statement submitted. Each indicator has three sub-indicators, which are then developed into ten statements. Student responses to problem-based learning with scaffolding generally showed positive reactions. Among these positive reactions, student responses to peer assistance were not as strong as student responses to other sub-indicators. This occurred because some students had not adapted well enough to the groups created by the researcher. The groups created by the researcher were felt to be unbalanced, resulting in some students being inactive in discussions. Although some students were inactive during discussions, there were several students who actively asked and answered questions posed to the teacher and peers during class. Based on these student opinions, it can be interpreted that students felt they were maximally involved in each learning process. During the process, students were more confident when asking questions to the teacher and classmates, in line with research by Ernawati et al. (2023) which showed that students who learned using problem-based learning with scaffolding had more courage to ask questions to the teacher and other students during the lesson. In contrast to student responses to their own performance, student responses to peer involvement in the discussion process received the lowest percentage of all statements, namely 76% (good). This occurs due to the same problem as student responses to peer assistance, namely some students are not very active during learning. This inactivity of a student is likely due to the student's difficulty in communicating their own opinions. Difficulty in communicating opinions usually occurs due to a gap in ability among students in the group (Haruehansawasin & Kiattikomol, 2018).

CONCLUSION AND RECOMMENDATION

Conclusion

Problem-based learning with scaffolding has an effect on students' creative thinking skills. This is indicated by the results of the hypothesis test on the pre-test and post-test data which show a significant difference between the two data in the

experimental class. The overall increase in creative thinking skills shows that the control class has a higher increase (0.36) than the experimental class (0.33). In contrast to the distribution of the gain value criteria categories in the experimental class, there are 6% experiencing high increases, 53% moderate increases, and 41% low increases; while the control class has a distribution of 0% in the high category, 72% in the moderate category, and 28% in the low category. The results of observations made by observers and researchers show that the experimental class has a higher level of sensitivity with a value of 70 (good) compared to the control class with a value of 50 (sufficient). The results of the analysis of student response data to problem-based learning with scaffolding show a very good response with an average level of agreement of 84%. The effect of problem-based learning with scaffolding on creative thinking skills has not been effective, this is indicated by only 14% of students who have scores above the KKM. The conclusion summarizes the descriptions presented in the results and discussion sections. Based on the descriptions in these two sections, the main points are developed, which constitute the essence of the description. The conclusion is presented in essay form, not numerical form.

Recommendation

The results of the data analysis on the homogeneity test of the creative thinking skills pre-test data showed that both classes had different data variances, so the study began at the point where the experimental class was superior. Based on this, it is recommended that both research classes have homogeneous data at the beginning of the study by conducting a pre-test, or determining the experimental and control classes after the results of the prerequisite test are obtained so that the assistance provided is on target.

ACKNOWLEDGMENT

We would like to express our gratitude to all parties involved in this research, both directly and indirectly. Our deepest gratitude goes to the teachers and staff of SMAN 10 Bandung who provided permission and facilitated the conduct of this research. We also extend our gratitude to the students in grades 11-7 and 11-9 who participated in the learning process.

REFERENCES

- Barrows, H. S. (1996). *4 Problem-Based Learning In Higher Education*.
- Belland, B. R., Kim, C. M., & Hannafin, M. J. (2013). *A Framework For Designing Scaffolds That Improve Motivation And Cognition*. Educational Psychologist, 48(4), 243–270. <https://doi.org/10.1080/00461520.2013.838920>
- Cachia, Romina., Ferrari, Anusca., Ala-Mutka, Kirsti., Punie, Yves., & Institute For Prospective Technological Studies. (2010). *Creative Learning And Innovative Teaching: Final Report On The Study On Creativity And Innovation In Education In The EU Member States*. Publications Office.
- Cahyono, A. N. (2010). *Vygotskian Perspective: Proses Scaffolding Untuk Mencapai Zone Of Proximal Development (ZPD) Peserta Didik Dalam Pembelajaran Matematika*. www.Labvirtualschool.Adinegara.Com

- Chirkov, V. I., & Ryan, R. M. Z. (2001). *Parent And Teacher Autonomy-Support In Russian And U.S. Adolescents: Common Effects On Well-Being And Academic Motivation*. *Journal Of Cross-Cultural Psychology*, 32(5), 618–635. <https://doi.org/10.1177/0022022101032005006>
- Collins, A., Brown, J. S., & Newman, S. E. (2018). *Cognitive Apprenticeship: Teaching The Crafts Of Reading, Writing, And Mathematics*. In *Knowing, Learning, And Instruction* (Pp. 453-494). Routledge.
- Ernawati, M. D. W., Yusnidar, Haryanto, Rini, E. F. S., Aldila, F. T., Haryati, T., & Perdana, R. (2023). *Do Creative Thinking Skills In Problem-Based Learning Benefit From Scaffolding ?* *Journal Of Turkish Science Education*, 20(3), 399–417. <https://doi.org/10.36681/Tused.2023.023>
- Fahlevi, R., Desak Made Santi Diwyarthi, N., Anurogo, D., Anwari, M., Herlambang, H. A., Aisyah Hidayati, S., Ulfa Nurdahlia, D., Agung Pramudito, A., Aji, R., & Andina Putri, G. (2023). *GERONTOLOGI*.
- Ferrer-Caja, E., & Weiss, M. R. (2000). *Predictors Of Intrinsic Motivation Among Adolescent Students In Physical Education*. *Research Quarterly For Exercise And Sport*, 71(3), 267–279. <https://doi.org/10.1080/02701367.2000.10608907>
- Gallagher, S. A., Sher, B. T., Stepien, W. J., & Workman, D. (1995). *Implementing Problem-Based Learning In Science Classrooms*. *School Science And Mathematics*, 95(3), 136–146. <https://doi.org/10.1111/J.1949-8594.1995.Tb15748.X>
- Greening, T. (1998). *Scaffolding For Success In Problem-Based Learning*. *Medical Education Online*, 3(1), 4297. <https://doi.org/10.3402/Meo.V3i.4297>
- Handayani, S. A., Rahayu, Y. S., & Agustini, R. (2021). *Students' Creative Thinking Skills In Biology Learning: Fluency, Flexibility, Originality, And Elaboration*. *Journal Of Physics: Conference Series*, 1747(1). <https://doi.org/10.1088/1742-6596/1747/1/012040>
- Hannafin, M., Land, S., & Oliver, K. (2013). *Open Learning Environments: Foundations, Methods, And Models*. In *Instructional-Design Theories And Models* (Pp. 115-140). Routledge
- Haruehansawasin, S., & Kiattikomol, P. (2018). *Scaffolding In Problem-Based Learning For Low-Achieving Learners*. *Journal Of Educational Research*, 111(3), 363–370. <https://doi.org/10.1080/00220671.2017.1287045>
- Hmelo-Silver, C. E., & Barrows, H. S. (2015). *Problem-Based Learning: Goals For Learning And Strategies For Facilitating*. In A. Walker, H. Leary, C. E. Hmelo-Silver, & P. A. Ertmer (Eds.), *Essential Readings In Problem-Based Learning: Exploring And Extending The Legacy Of Howard S. Barrows* (Pp. 69–84). West Lafayette, IN: Purdue University Press.
- Kasuga, W., Maro, W., & Pangani, I. (2022). *Effect Of Problem-Based Learning On Developing Science Process Skills And Learning Achievement On The Topic Of Safety In Our Environment*. *Journal Of Turkish Science Education*, 19(3), 872–886. <https://doi.org/10.36681/Tused.2022.154>
- Kim, N. J., Belland, B. R., & Axelrod, D. (2019). *Scaffolding For Optimal Challenge In K–12 Problem-Based Learning*. *Interdisciplinary Journal Of Problem-Based Learning*, 13(1). <https://doi.org/10.7771/1541-5015.1712>
- Kim, N. J., Belland, B. R., & Walker, A. E. (2018). *Effectiveness Of Computer-Based Scaffolding In The Context Of Problem-Based Learning For Stem Education: Bayesian Meta-Analysis*. *Educational Psychology Review*, 30(2), 397–429. <https://doi.org/10.1007/S10648-017-9419-1>

- Nahar, L. (2023). *The Effects Of Standardized Tests On Incorporating 21st Century Skills In Science Classrooms*. Integrated Science Education Journal, 4(2), 36–42. <https://doi.org/10.37251/Isej.V4i2.324>
- Nasrullah, Kartini, & Muspiroh, N. (2018). *Jurnal Ilmu Alam Indonesia Penerapan Model Pembelajaran PBL (Problem Based Learning) Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Kelas XI Pada Konsep Sistem Ekskresi Di MAN 3 Cirebon*. Jurnal Ilmu Alam Indonesia, 01(02), 101–112. www.syekhnurjati.ac.id/jurnal/index.php/jia
- Nurulsari, N., Abdurrahman, & Suyatna, A. (2017). *Development Of Soft Scaffolding Strategy To Improve Student's Creative Thinking Ability In Physics*. Journal Of Physics: Conference Series, 909(1). <https://doi.org/10.1088/1742-6596/909/1/012053>
- Oliver, K., & Hannafin, M. J. (2000). *Student Management Of Web-Based Hypermedia Resources During Open-Ended Problem Solving*. Journal Of Educational Research, 94(2), 75–92. <https://doi.org/10.1080/00220670009598746>
- Park, M. H., Tiwari, A., & Neumann, J. W. (2020). *Emotional Scaffolding In Early Childhood Education*. Educational Studies, 46(5), 570–589. <https://doi.org/10.1080/03055698.2019.1620692>
- Putri, M. A., & Simbolon, P. A. L. (2022). *Model Pembelajaran Problem Solving Dan Korelasinya Terhadap Kemampuan Berpikir Kritis Siswa*. Journal Evaluation In Education (JEE), 3(3), 87–91. <https://doi.org/10.37251/Jee.V3i3.263>
- Ratanasabilla, N. E., Sriyati, S., & Hamdiyati, Y. (2021). *Penerapan Peta Konsep Sebagai Strategi Asesmen Formatif Dalam Upaya Meningkatkan Hasil Belajar Siswa Pada Pembelajaran Sistem Koordinasi*. Assimilation: Indonesian Journal Of Biology Education, 4(1), 16-23.
- Reece, J. B., & Campbell, N. A. (2011). *Campbell Biology*. Benjamin Cummings / Pearson
- Restriani Adiwijayanti, D., Yusmin, E., & Astuti Program Studi Pendidikan Matematika FKIP Untan Pontianak, D. (2018). *KEMAMPUAN BERPIKIR KREATIF DITINJAU DARI KEMAMPUAN ANALOGI DALAM MENYELESAIKAN MASALAH OPEN-ENDED DI SMP*.
- Ruseffendi, E. T. (2006). *Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya Dalam Pengajaran Matematika Untuk Meningkatkan CBSA*. Bandung: Tarsito, 336-337.
- Sakir, N. A. I., & Kim, J. G. (2020). *Enhancing Students' Learning Activity And Outcomes Via Implementation Of Problem-Based Learning*. Eurasia Journal Of Mathematics, Science And Technology Education, 16(12), Em1925. <https://doi.org/10.29333/Ejmste/9344>
- Salih M (2010) Developing Thinking Skills In Malaysian Science Students Via An Analogical TaskJ. Sci. Math. Educ. Southeast Asia 33 110-28.
- Santrock, J. W., & Santrock, J. W. (2007). *Psikologi Pendidikan Edisi Kedua*.
- Saye, J. W., & Brush, T. (2004). *Scaffolding Problem-Based Teaching In A Traditional Social Studies Classroom*. Theory And Research In Social Education, 32(3), 349–378. <https://doi.org/10.1080/00933104.2004.10473259>
- Sg Noviana Aryani Pucangan, A. A., Koes Handayanto, S., & Wisodo, H. (2018). *Pengaruh Scaffolding Konseptual Dalam Problem Based Learning Terhadap Kemampuan Pemecahan Masalah*. <http://journal.um.ac.id/index.php/jptpp/>

- Situmorang, R. M., Muhibbudin, & Khairil. (2015). *Rosdiana Meliana Situmorang Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Hasil Belajar Siswa Pada Materi Sistem Ekskresi Manusia*.
- Torrance, E. P. (2018). *Torrance® Tests Of Creative Thinking*.
- Tuckman, B. W., & Schouwenburg, H. C. (2004). *Behavioral Interventions For Reducing Procrastination Among University Students*.
- Wahyuningsih, A. N. (2012). *PENGEMBANGAN MEDIA KOMIK BERGAMBAR MATERI SISTEM SARAF UNTUK PEMBELAJARAN YANG MENGGUNAKAN STRATEGI PQ4R*. In JISE (Vol. 1, Issue 1). [Http://Journal.Unnes.Ac.Id/Sju/Index.Php/Jise](http://Journal.Unnes.Ac.Id/Sju/Index.Php/Jise)
- Wicaksono, I. (2017). *The Effectiveness Of Virtual Science Teaching Model (Vs-Tm) To Improve Student's Scientific Creativity And Concept Mastery On Senior High School Physics Subject*.
- Wood, D., Bruner, J. S., & Ross, G. (1976). *The Role Of Tutoring In Problem Solving**. In J. Child Psychol. Psychiat (Vol. 17). Pergamon Press.
- Yolviansyah, F., & Hermanto, H. (2023). *Literature Study: Academic Supervision By The Principal To Improve The Quality Of Educators*. Edufisika: Jurnal Pendidikan Fisika, 8(1), 16–22. <https://doi.org/10.59052/Edufisika.V8i1.22615>

