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Do creative thinking skills in problem-based learning benefit from scaffolding?

M. Dwi Wiwik Ernawati[1], Yusnidar[2], Haryanto[3], Endah Febri Setiya Rini[4], Febri Tia Aldila[5], Tri Haryati[6], Rahmat Perdana[7]

[1]*Universitas Jambi, Indonesia, md.wiwik.ernawati@unja.ac.id, ORCID ID: 0000-0001-9908-2373*
[1]*Universitas Jambi, Indonesia, ORCID ID: 0009-000126310053*
[3]*Universitas Jambi, Indonesia, ORCID ID: 0000-0002-8322-2922*
[4]*Sebelas Maret University, Indonesia, ORCID ID: 0000-0002-4984-8577*
[5]*Yogyakarta State University, Indonesia, ORCID ID: 0000-0002-5944-7056*
[6]*Universitas Jambi, Indonesia, ORCID ID: 0000-0002-8337-7131*
[7]*Universitas Jambi, Indonesia, ORCID ID: 0000-0003-1648-0291*

ABSTRACT
Creative thinking skills are recognised 21 century skills. This study aimed to determine whether students' creative thinking skills in biochemistry courses are improved through scaffolding-based problem-based learning. The study employed a mixed methods approach with a sample of 113 chemistry education programme students at Jambi University. An observation sheet instrument was used to gauge students' creative thinking skills during learning, test questions were used to gauge them after the implementation of Problem Based-learning, and an interview instrument was used to see how students responded once PBL learning had been implemented. Descriptive statistical testing techniques were applied to data between classes. It was found that there were significant differences in students' creative thinking skills after scaffolding-based PBL learning had been carried out. The biochemistry learning process was found to be conducive to scaffolding in problem-based learning. Providing scaffolding in problem-based learning also has a positive impact on students because this study proves that students become more active learners in education because the problem-solving process requires students to express opinions and exchange ideas.

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Introduction

In the current era, learning has begun to be adapted to the development of science and technology (Aldila et al., 2023; Asniza et al., 2021; Fitriyana et al., 2021; Syawaludin et al., 2022). Effective learning is learning that involves direct experience and meaningful interactions between educators and students (Aldila et al., 2021; Özalemdar, 2021; Morgado et al., 2022; Sanova et al., 2022; Asrial et al., 2023). In essence, the learning process is not a process of memorising and accumulating knowledge but a communication process in the form of delivering messages from the stimulus and recipient (Darmaji et al., 2021; Setiya et al., 2021; Suhara & Kiska, 2022; Rahadiyani., Rivani., & Untari., 2023). Attractive learning designs can increase students' interest and motivation to learn and find a solution (Kibga et al., 2021; Rini et al., 2021; Tayibu & Faizah, 2021). Teachers need to improve their quality of instruction to provide the best service to students (Darmaji et al., 2022a; Nozomi., 2023). Teachers can choose the right strategy and create cooperative and problem-based learning to create interactive conditions in the classroom (Gillies, 2016; Sukarni, 2021; Putri & Simbolon, 2022; Prambanan., Yathasya., & Anwar, 2023). Practical and interactive learning is also very much needed in biochemistry learning.

Biochemistry at the university this study was carried out involves a group of courses that describe chemical reactions that occur in the bodies of living things. Biochemistry is included in science courses with various applications in agriculture, medicine, and industry (Nelson & Cox, 2008; Mutlu, 2018; Seruni et al., 2019; Rini & Aldila, 2023; Aldila et al., 2023; Kartina et al., 2023). At universities in Indonesia, biochemistry courses are also studied by students majoring in chemistry (Yunita et al., 2017; Darmaji, 2022). Several studies say that biochemistry is one of the most challenging subjects for students to understand (Varghese et al., 2012; Fitriyana et al., 2021; Karuku, 2023). This is because abstract concepts require a high level of thinking which can be an obstacle when learning biochemistry (Varghese et al., 2012; Zhou et al., 2015). To help overcome this, students must learn about problem-solving strategies to guide them in solving problems, which is practising creative thinking.

Creative thinking is a recognised 21st-century skill. Creative thinking is the ability of the thinking process to generate new and unique ideas to solve problems (Zubaidah et al., 2017; Istiyono et al., 2018; Batlolona et al., 2019; Eska et al., 2023; Hidayati et al., 2023; Nahar, 2023). Creative thinking includes originality, flexibility, fluency, and elaboration (Batlolona et al., 2019; Kholilah et al., 2020; Torrance, 2006). Simkova, Bondarenko, and Bielovetska (2021) discuss web-based applications that can develop students' remote creative thinking skills, as well as integrated virtual reality effects that can improve their exploration and creative thinking (Hu et al., 2016; Fitriani, et al., 2021; Kiraga, 2023). Based on research by Ernawati *et al.* (2019), students' creative thinking ability on biochemical material is less than 50 percent in the satisfactory category. Based on this research, creative thinking skills and biochemistry learning need special attention and play an essential role in education. Problem-based learning models can improve creative thinking skills (Ersoy & Başer, 2014; Mundilarto, 2017; Castro, 2023). The formation and development of students' creative thinking skills can be done by integrating them into every learning experience in the classroom. The learning model chosen to develop students' creative thinking skills in this study is problem-based.

Problem-based learning is a learning model that challenges students to "learn how to learn" to find solutions to real-world problems (Kasuga et al., 2022; Ramadhanti et al., 2022; Bayar & Çepni, 2022). Problem-based learning is an instructional approach considered student-centred, where students can develop thinking skills by examining problems from various perspectives (Marzuki & Basariah, 2017; Naji et al., 2020; Sakir & Kim, 2020). In problem-based learning, students explore problems and use their existing knowledge to further develop their skills and build new learning (Shishigu et al., 2018; Al Said et al., 2019). Problem-based learning can help students know the basic concepts to positively impact learning (Swart, 2014; Ediansyah et al., 2019; Yolvianysah et al., 2021). In addition, problem-based learning is effective in helping students develop a positive attitude toward subjects and improving student achievement (Demirel & Dağyar, 2016; Argaw et al., 2017; Matondang et al., 2021). This is supported by research by Wartono et al. (2018), which states that students' creative thinking skills score using problem-based learning models is higher than in conventional learning. Problem-based learning will be effective if the application is assisted by a tutor (scaffolding).

Scaffolding is a supportive interaction by guiding and providing necessary resources to solve problems (Razaghi et al., 2019; Hermawati & Chen, 2023; Pitriyani & Fitriani, 2023). Scaffolding is considered a strategy that refers to solving problems or to improve the quality of their scientific arguments (Chotirat & Teosakul, 2017; Weng et al., 2017; Atsumbe et al., 2018; Yolviansyah & Hermanto, 2023). Scaffolding can help students fix problems, simplify complex tasks, or explain complex procedures (Park et al., 2020; Syarkowi et al., 2023; Wulandari & Jumadi, 2023). Some students may need extra guidance support through scaffolding (Dagoc & Tan, 2018; Chen & Tseng, 2019). Haruehansawasin & Kiattikomol (2018) suggested that the scaffolding approach could support problem-based learning. The provision of scaffolding can be adjusted to the problems or characteristics students face and according to the characteristics of teaching materials to improve their creative thinking skills. For example, one of the teaching subject that require scaffolding is biochemistry.

To overcome this, students must learn about solutions to be motivated to produce answers and cognitive abilities that can guide them in solving problems, one of which is practicing creative thinking. Several studies have been conducted to innovate learning, such as using problem-based learning models combined with assisting (scaffolding). In their research, Kim et al. (2019) stated that learner-centered scaffolding systems enhance students' experience with the existence of various types of scaffolding according to the needs and difficulties of different students in problem-based learning. Meanwhile, Gita & Apsari (2018) reported that applying scaffolding in problem-based learning improved student learning achievement. Studies by Pucangan et al. (2018) show that scaffolding has a conceptual influence on problem-based learning and problem-solving abilities.

Research by Grady et al. (2012) explained that project-based learning provides extensive scaffolding and guidance to facilitate meaningful learning. Studies by Fajriani et al. (2021) show that developing problem-based learning materials equipped with scaffolding can improve students' thinking skills. Nurulsari et al. (2017) reported that the scaffolding strategy effectively improved students' creative thinking skills. The provision of scaffolding can be adjusted to the characteristics or problems faced by students so that they can improve their creative thinking skills. This shows that the ability to think creatively for students is essential to be owned and improved through applying a learning model with scaffolding following the characteristics of the teaching material. This again shows that creative thinking for students is essential, and improving students' creative thinking skills through applying problem-based learning models with scaffolding following the characteristics of teaching materials is necessary. Biochemistry I course requires the ability to understand concepts and in-depth materials, so creative thinking skills are needed to bring up new ideas to solve biochemical problems. Therefore, analysis is needed to determine students' creative thinking skills in the biochemistry I course by applying problem-based learning with scaffolding.

The purpose of this study was to find out whether students' creative thinking skills in biochemistry courses are improved through scaffolding-based problem-based learning. This research is focused on answering the research questions below.

1. How are students' creative thinking skills in biochemistry learning when using a scaffolding-based problem-based learning model?
2. Are there differences in students' creative thinking abilities using a problem-based learning model based on scaffolding?

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Methods

Research Design

A mixed methods research approach combining quantitative and qualitative research was employed (Creswell, 2013; Vebrianto et al., 2020; Syahrial et al., 2022). Quantitative methods are the primary, measurable, and descriptive data sources. In contrast, qualitative methods are a supporting source in proving, deepening, and expanding quantitative data (Rahma & Sumarti, 2016; Rini et al., 2021; Darmaji et al., 2022). Quantitative data were obtained from observation sheets in problem-based learning and students' creative thinking ability test questions. In addition, qualitative data were obtained from interviews.

Sample

The population in this study were students of the chemical education study programme, faculty of teaching and science education, and Jambi university who took the biochemistry course 1. Sampling for quantitative data was carried out through a total sampling technique with a total sample of 113 samples spread roughly evenly across three classes. Sampling for qualitative data used a purposive sampling technique by selecting informants for each class 1 representative so that there are three students as informants. With the best category criteria of each research variable that has been distributed by researchers.

Data Collection Technique

As noted earlier, there are two kinds of data collected in this study. First, quantitative data is used to measure students' creative thinking skills. The instruments used are biochemical creative thinking ability test questions and observation sheets. Then, qualitative data is used to see how students respond to biochemistry learning using a scaffolding-based problem-based learning model.

This creative thinking skill assessment instrument has been validated by material, construct, and language experts and is declared valid based on the item validity test at the limited empirical test stage and broad trial. This creative thinking skill assessment instrument consists of 16 items, each having four descriptor scores in stages. The following is a grid table of creative thinking skills assessment instruments.

Table 1

The Instrument of the Creative Thinking Ability Observation Sheet Grid

No.	Aspect	Observable Indicators	Item Number
1.	Sensitivity	• Speed in asking questions • Speed of responding to questions • Speed to conclude the problem being discussed.	1, 2, 3
2.	Fluency	• Generating many ideas in solving problems • It gives many ways or suggestions for doing things • Work faster and do more to solve problems	4, 5, 6
3.	Flexibility	• Generate problem-solving ideas or answers to a variety of questions • Can see a problem from different perspectives. • Present a concept differently (with a slate of presentation, style, expression, or expression.	7, 8, 9
4.	Originality	• Provide new ideas for solving problems. • Develop or enrich the ideas of others. • You are adding or detailing an idea so as to improve the quality of the idea.	10, 11, 12
5.	Elaborate	• Can determine the truth of a question or the truth of a problem-solving plan. • Can ideas to solve a problem and can implement them properly. • Have a justifiable reason for reaching a decision. • State the reasons for the truth of the answers/statements.	13, 14, 15, 16

This creative thinking skill observation sheet instrument has been validated by material, construct, and language experts. The creative thinking ability essay test questions are two questions with material related to enzymes that have been adapted to the learning achievements of graduates of the chemistry study programme at Jambi University, Indonesia.

Table 2

Grid of Instruments about Creative Thinking Skills

Aspects of Creative Thinking Indicators	Question Indicator	Distribution of Questions
Sensitivity Fluency Flexibility Orisinality Elaboration	Explain in detail, smoothly, and correctly by including the reaction mechanism in masking tape.	1
Sensitivity Fluency Flexibility Orisinality Elaboration	Can prove in detail and precisely that four healthy five perfect foods can facilitate metabolic processes by including four examples of changes in chemical body reactions, regarding enzyme activity requiring coenzymes and enzyme cofactors".	2
Sensitivity Fluency Flexibility Orisinality Elaboration	Can explain correctly, fluently, and in detail by including two examples of enzymes for each regulatory mechanism.	3
Sensitivity Fluency Flexibility Orisinality Elaboration	Can prove correctly and in detail by including the relationship between substrate concentration and reaction rate	4
Sensitivity Fluency Flexibility Orisinality Elaboration	Can be proven precisely and correctly by including the equation for the reaction rate of glucose converted to fructose by the enzyme glucose isomerase.	5

Then, the interview instrument guide consists of 10 questions regarding student responses to the scaffolding problem-based learning model in improving students' creative thinking skills. This instrument has been validated by two experts.

Table 3

Student Interview Response Instrument Grid

No.	Indicator Aspect	Sub-Aspect Indicators	Question Number
1.	Student responses to learning with a scaffolding-based problem-based learning model	Response to learning	1, 3, 4
		When a scaffolding-based problem-based learning model is applied	2
		Can scaffolding-based problem-based learning foster a creative attitude and encourage collaboration?	6, 7
2.	Seeing problem-solving with students' creative thinking skills	Students can work on test questions quickly after using the applied model	9
		Students appear confident to ask questions	5
		Student discussion in groups	8, 10

Data Analysis

Quantitative data were obtained from the results of filling out biochemical creative thinking questions and observation sheets which were then tested by ANOVA through IBM SPSS Statistic 23 software to determine differences in students' creative thinking skills. However, before the data can be tested for ANOVA, it is necessary to carry out a prerequisite test which includes tests for normality and homogeneity (Aldila & Rini, 2023; Astalini et al., 2023; Darmaji et al., 2020; Darmaji et al., 2022).

While qualitative data were obtained from interviews with students, then all interview data were collected and then sorted based on data that were considered essential then the data were analysed in more detail by (grouping into segments) the data (Kamid et al., 2021; Ramadhanti, Simamora, et al., 2022; Syahrial et al., 2022; Syaiful et al., 2020). Then, connecting between segments to be interpreted and summarising the results of the findings that have been obtained in the form of descriptive narratives.

Findings

The data description of students' creative thinking skills for problem-based learning with scaffolding in the biochemistry course on enzymes and enzyme cofactors can be summarised in Table 4.

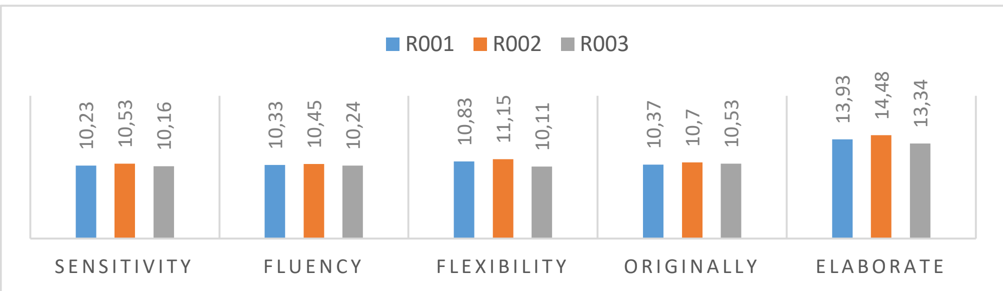
Table 4

Description of the Cognitive Value and Self-Assessment of Students' Creative Thinking Skills

Description of the Cognitive Value of Students' Creative Thinking Skills					
Class	Interval	Category	F	(%)	Mean
R001	0.00 – 25.0	Very bad	0	0%	68.37
	25.01 – 50.0	Bad	4	11.4%	
	50.01 – 75.0	Good	25	71.4%	
	75.00 – 100.0	Very good	6	17.1%	
R002	0.0 – 25.0	Very bad	0	0%	79.03
	25.1 – 50.0	Bad	3	7.5%	
	50.1 – 75.0	Good	14	35%	
	75.0 – 100.0	Very good	23	57.5%	
R003	0.0 – 25.0	Very bad	1	2.6%	67.63
	25.1 – 50.0	Bad	6	15.8%	
	50.1 – 75.0	Good	23	60.5%	
	75.0 – 100.0	Very good	8	21.1%	

Figure 1

Histogram of Self-Assessment Scores On Students' Creative Thinking Skills



Based on the results in Table 4 and figure 1, the highest quality of cognitive value achievement on students' creative thinking skills for problem-based learning with scaffolding is in class R002. On the sensitivity indicator, class R002 obtained the highest quality of achievement of self-assessment scores compared to other classes, with an average of 10.53. In the fluency indicator, class R002 obtained the highest quality of achievement of self-assessment scores compared to other classes, with an average of 10.45. In the flexibility indicator, class R002 is the class with the highest quality of achieving self-assessment scores, with an average of 11.15. Furthermore, on the originality indicator, class R002 obtained the highest quality of achievement of self-assessment scores compared to other classes, with an average of 10.70. Then, on the elaborate indicator, class R002 obtained the highest quality of achievement of self-assessment scores compared to other classes, with an average of 14.48.

Table 5

The Results of the Normality Test and the Homogeneity Test of Cognitive Values and Self-Assessment Values of Students' Creative Thinking Skills

The Results of the Normality Test of Cognitive Values and the Value of Self-Assessment of Students' Creative Thinking Skills			
Cognitive Value			
Class	Statistic	Df	Sig.
R001	.945	35	.078
R002	.946	40	.086
R003	.946	38	.085
Self-assessment Value			
Class	Statistic	Df	Sig.
R001	.937	35	.077
R002	.947	50	.141
R003	.946	38	.131

Based on the results of data analysis, the cognitive value variable and the self-assessment value variable in classes R001, R002, and R003 have been customarily distributed and homogeneous with the decision-making value of significance or Sig. > .05. Therefore, using the ANOVA test, the cognitive value of students' creative thinking skills in grades R001, R002, and R003 can be compared to see the difference in the value of creative thinking in each class.

Table 6

The Results of the ANOVA Test of Students' Creative Thinking Skills

Anova					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3158.737	2	1579.369	8.001	.001
Within Groups	21713.989	110	197.400		
Total	24872.726	112			

The table above shows that the significance value of the cognitive value variable based on the results of the ANOVA test 0.001 < .05. Based on the decision-making criteria, H0 is rejected and H1 is accepted. The cognitive value of creative thinking ability due to problem-based learning with scaffolding in the biochemistry course on enzymes and enzyme cofactors is significantly different.

Differences in cognitive values on students' critical thinking skills can be analysed further by post hoc tests to see which class has different creative thinking skills, as shown in Table 7.

Table 7

Post Hoc Test Results (Multiple Comparisons)

Multiple Comparisons						
(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
R001	R002	-10.654	3.252	.004	-18.38	-2.93
	R003	.740	3.292	.973	-7.08	8.56
R002	R001	10.654	3.252	.004	2.93	18.38
	R003	11.393	3.183	.001	3.83	18.96
R003	R001	-.740	3.292	.973	-8.56	7.08
	R002	-11.393	3.183	.001	-18.96	-3.83

The post hoc test results were carried out to determine the location of the differences in cognitive values on students' creative thinking skills. The difference in cognitive value on students' creative thinking skills lies in class R001, class R002, and class R002 and R003 with decision making are Sig. < .05. Thus, there is no significant difference in cognitive scores on creative thinking skills between classes R001 and R003.

The results of the interviews showed that problem-based learning with scaffolding in biochemical enzymes and cofactor enzymes courses improved students' creative thinking skills. Students show an excellent response to biochemistry learning that applies a problem-based learning model by providing scaffolding on biochemical material, with the results of interviews from questions 1, 3, and 4 generated and conclusions obtained;

Sample R001 said, *"I feel happy, interested, and more interested in studying biochemistry by applying problem-based learning. learn with scaffolding because it makes it easier for me to understand biochemical material".*

Sample R002 said, *"Learning with a problem-based learning model is very effective and makes us think more deeply because problems are posed."*

Sample R003 said, *"I am more interested in studying biochemistry than usual; with the problem-based learning model, we are motivated to be active in the classroom, and the scaffolding makes us understand more about biochemical material."*

Students also show a good attitude towards biochemistry learning that applies problem-based learning models by providing scaffolding on biochemical material, with the results of interview questions no. 2, 6, and 7.

Samples R001, R002, and R003 said, *"Learning biochemistry that applies problem-based learning with scaffolding makes me more active in opinion, more diligent, more critical, and creative in finding solutions to the problems found."*

Students' creative thinking skills that emerged from biochemistry learning that applied a problem-based learning model by biochemical scaffolding material showed promising results. Students found it easier to work on test questions in biochemistry learning with a problem-based learning model by providing scaffolding as is indicated by the conclusions of the informant interview in the form of:

"It helps me in doing biochemical test questions if the problem based learning scaffold is given."

Furthermore, students are trained in group learning in biochemistry learning with problem-based learning that provides scaffolding which is indicated by the results of interviews in the form of:

"Currently, I often discuss with friends and lecturers about the problems being studied. Discussions are carried out in groups made by the lecturer."

Then students are more daring to ask lecturers and friends in biochemistry learning with a problem-based learning model by providing scaffolding which is shown by the conclusions of 3 informants in the form of

> *"I became more daring to ask lecturers or friends in problem-based biochemistry learning models by providing scaffolding. Because the next question that arises will be discussed together to find a solution."*

Discussion

The data analysis that has been carried out shows that there is a significant difference in the acquisition of cognitive scores for creative thinking skills for problem-based learning with scaffolding in biochemistry courses on enzymes and enzyme cofactors.

The average score of cognitive value achievement on creative thinking skills for problem-based learning with scaffolding in the biochemistry course on enzymes, enzymes, and cofactors in class R002 has reached the expected ideal average score of 75.00. The average score of cognitive achievement on creative thinking skills in class R002 is moderate, 79.03. Meanwhile, the achievement of cognitive scores on creative thinking skills for problem-based learning using scaffolding in the biochemistry course on enzymes and enzyme cofactors in classes R001 and R003 has yet to reach the expected ideal average score of 75.00. Class R001 obtained an average score of 68.37 for the cognitive achievement of creative thinking skills, which is classified as low. Then, class R001 obtained an average score of 67.63 for the cognitive value of creative thinking skills, which is also low. The average difference and the analysis of the significance of the ANOVA test of $.001 < .05$ indicates that students in classes R001, R002, and R003 have different cognitive scores for creative thinking skills. The difference in cognitive scores of creative thinking skills is in class R001, which is different from class R002. Class R002 differs from class R003, where class R002 gets the most significant average cognitive score of creative thinking skills compared to other classes.

Sungur, Tekkaya & Geban (2010) argued that problem-based learning can make students understand concepts better and are more proficient in helping them organise relevant information. A study by Bara & Xhomara (2020) shows the correlation between problem-based learning and academic achievement. It shows that student-centred learning and problem-based learning significantly affect academic achievement. Furthermore, Kumar & Kogut, (2006) reported that problem-based learning made students actively participate in an interactive dialogue. Other than that, Sungur, Tekkaya & Geban (2010) also suggested that problem-based learning should be integrated with the curriculum to improve higher cognitive processes.

The form of higher-order thinking skills studied in this study is creative thinking. Creative thinking skills can be improved with problem-based learning. Khoiriyah & Husamah (2018) found that implementing problem-based learning in schools increased student learning outcomes, creative thinking, and problem-solving skills. Ulger (2018) said that problem-based learning could help students solve problems, thereby increasing creative thinking. Rudibyani, (2019) found that schools can implement problem-based learning in schools because they are able to improve students' creative thinking skills on stoichiometric material. Problem-based learning will introduce students to a problem to raise their high-level thinking skills, including creative thinking skills. Sihaloho et al. (2017) said that students' ability to think creatively and problem-solve is influenced by problem-based learning that is applied in schools.

Some of the findings above, when associated with this study's results, support and strengthen the previous findings. Other than that, Orozco & Yangco (2016) found that problems that arise in problem-based learning act as a stimulus for students in teaching and learning activities. In addition, creative thinking skills have creative thinking indicators as aspects that are studied more deeply. Surya et al. (2017) show that problem-based learning involves real problems but needs to be better structured so it raises creative thinking skills. In line with Ratnaningsih (2019) shows that there are still things that could be improved in the creative thinking process, especially in the indicators of originality and flexibility in the application of problem-based learning. To reduce errors in the creative thinking process, problem-based learning needs to be assisted by tutors (scaffolding).

Sholahuddin et al., (2020) show that students are successfully assisted in doing very complex scientific tasks through scaffolding. The primary purpose of scaffolding is to help students increase their learning activity and solve problems beyond their abilities (Huang, 2019). Research conducted by Mudrikah (2016) states that the assistance (scaffolding) provided in problem-based learning can be a further stimulus for students to take action following expectations so that it has an impact on higher-order thinking skills. The results of research conducted by Tawfik & Kolodner (2016) show that many implementations of problem-based learning are unsuccessful, so using scaffolding in problem-based learning is recommended to support more effective implementation. Scaffolding is the most prominent thing in problem-based learning, where it can take various forms (MacLeod & Veen, 2019). In line with research by Kusmaryono and Wijayanti (2020), who conducted a literature study on scaffolding for six years (2015-2020) from Australia, the Netherlands, the United States, Turkey, and Indonesia so that it was concluded that scaffolding is essential for learning because it provides alternative course solutions. Further research was conducted by Yuriev et al. (2017), who designed, implemented, and evaluated scaffolding in the form of "Goldilocks Helps" needed to develop problem-solving skills in chemistry.

Problem-based learning by providing scaffolding creates a more conducive, innovative, and fun learning situation. Murray (2012) stated that problem-based learning and scaffolding allow real-time feedback. Furthermore, Panyapisit & Tiantong (2018) revealed that problem-based learning with scaffolding would reduce the pressure experienced by students so that they can solve the assigned problems. Giving scaffolding to chemical education students who study enzymes, coenzymes, and cofactors with a problem-based learning model makes learning more active because student participation increases. Students can solve problems in a structured manner due to the assistance provided. The provision of scaffolding also trains students to be independent after receiving sufficient assistance. In problem-based learning, students are asked to be more active in the learning process. Students will be allowed to express their ideas related to the studied problems. Lecturers play a role in providing motivation by asking questions that explore the knowledge that is in the minds of students. In addition, lecturers also provide stimulus assistance in problem-solving. Thus, students can examine problems better so that learning is easy to understand.

The results of the interviews showed that problem-based learning with scaffolding in the enzyme biochemistry and enzyme cofactor courses improved students' creative thinking skills. In addition, students show an excellent response to biochemistry learning that applies a problem-based learning model by providing scaffolding on biochemical material, with the results of the interview being *"I feel happy, interested, and more interested in studying biochemistry by applying problem-based learning. learn with scaffolding because it makes it easier for me to understand biochemical material".* Students also show a good attitude towards biochemistry learning by applying a problem-based learning model by providing scaffolding on biochemical material.

Students' creative thinking skills that emerged from biochemistry learning that applied a problem-based learning model by biochemical scaffolding material showed promising results. Students are easier to work on test questions in biochemistry learning with a problem-based learning model by providing scaffolding. Furthermore, students are trained in group learning. Students are more daring to ask lecturers and friends in biochemistry learning with a problem-based learning model by providing scaffolding which is indicated by the results of interviews in the form of *"I have become more daring to ask lecturers or friends in the problem-based biochemistry learning model. by providing scaffolding. Because the next question that arises will be discussed together to find a solution."* Applying a problem-based learning model with scaffolding will help students strengthen their problem-solving skills to improve their creative thinking skills. This study examines creative thinking skills by applying a problem-based learning model with scaffolding in enzyme, coenzyme, and cofactor biochemistry courses.

Many studies focused on problem-based learning using scaffolding have been carried out.

This research is in line with Sugiyanti & Muhtarom (2016), which shows that students' thinking skills when working on problems about the field are more developed because students are able to use all information to solve problems by providing scaffolding that is adapted to students' thinking abilities. However, this study only examines students' thinking skills when working on questions about the field by providing scaffolding without applying a problem-based learning model. Research conducted by Hayanah et al. (2019) found that the ability to determine the main idea of fifth-grade students of SD Gugus RA Kartini, Semarang Regency was able to increase by applying problem-based learning based on scaffolding strategy. However, this research only focuses on the material to determine the main idea. Ariyanti & Hermita (2020) stated that problem-based learning with scaffolding increased students' mathematical modeling skills. However, the research only focused on improving mathematical modeling skills.

Based on the studies on problem-based learning with scaffolding that have been carried out above. This research was conducted to complement research on problem-based learning with existing scaffolding. Previous studies only examined the provision of scaffolding in problem-based learning to improve thinking skills, determining main ideas, mathematical modeling skills, and problem-solving abilities. No research examines the provision of scaffolding in problem-based learning with enzymes, coenzymes, and cofactors that aim to measure students' creative thinking skills. So this research complements previous studies by examining students' creative thinking skills for problem-based learning using scaffolding in biochemistry courses, especially enzymes, coenzymes, and cofactors.

Problem-based learning with scaffolding that impacts increasing creative thinking skills in biochemistry courses, especially enzymes, coenzymes, and cofactors, is carried out in 7 stages. The seven syntaxes or stages are: (1) Problem orientation, orientation to the problem to be solved is the primary goal of problem-based learning. (2) Group discussion: At this stage, a discussion is held to determine the strategy to solve the problem. (3) Classical discussion of problem-solving, at this stage, implementing strategies (dividing tasks for each group member), processing information/data/facts, constructing problem-solving results in presentations, and presenting problem-solving in classical discussions. (4) Stage I scaffolding, at this stage, the lecturer in charge of the course provides input/comments (scaffolding). (5) Elaboration, at this stage, participants present a new problem as a form of elaboration on the discussed topic. (6) Classical discussion of elaboration, this stage is an evaluation of the results and process of solving the problem of phase I, which is carried out in a classical discussion. (7) Stage II scaffolding, at this stage is given in the form of finalization of the resolution of the problems being discussed to become more detailed, broad, and in-depth.

This research has a novelty that is trying to be analysed, namely testing creative thinking skills in problem-based learning using scaffolding in biochemistry courses, especially enzymes, coenzymes, and cofactors, that other researchers have yet to do. Enzyme, coenzyme, and cofactor materials are essential learning materials in biochemistry courses. Therefore, researchers are interested in studying them by doing several tests, namely descriptive statistical tests consisting of two cognitive and self-assessment values. The next test is the prerequisite test, namely the normality and homogeneity tests. Then test, the assumptions using the ANOVA test and further tests to see the differences in creative thinking skills.

The limitation of this research is that it only examines students' creative thinking skills for problem-based learning using scaffolding in biochemistry courses, especially enzymes, and enzyme cofactors. However, testing of other learning skills, such as critical thinking skills and other skills, has yet to be carried out. Therefore, expanding the study of other skills in learning is significant to be studied in further research. Researchers suggest conducting further research to compare other higher-order thinking skills. One is critical thinking skills that can be analysed in problem-based learning with scaffolding.

Conclusion and Implications

This study concludes that students' creative thinking skills in biochemistry learning when using a problem-based learning model based on scaffolding in classes R001, R002, and R003 show good results. This can be seen from the percentage of students' ability to think creatively in learning biochemistry when using a problem-based learning model based on scaffolding. In class R001, 71.4% of students are in a suitable category. In class R002, 57.5% of students are in the excellent category. Then, in class R003 as many as 60.5% of students are in a suitable category. Then, there is a difference between students' creative thinking abilities in biochemistry courses using problem-based learning models based on scaffolding in classes R001, R0002, and R003. This difference can be seen from the ANOVA test which was obtained with a significance value of 0.001 because the significance value is less than 0.05 (Sig. <0.05), the data obtained has a significant difference in creative thinking skills in class R001, R002, and R003. Furthermore, it is further analysed using a post hoc test to see which class has a difference. Where the post hoc test results showed differences in students' creative thinking abilities in biochemistry learning when using the scaffolding-based problem-based learning model were found in class R001 and class R002 as well as class R002 and class R003 with a decision-making significance value (Sig. <0.05). This research is expected to contribute to educators in improving the quality of learning in an educational institution. Providing scaffolding in each learning model used by educators is expected to impact increasing creative thinking and other abilities.

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