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Application of Problem-Based Learning to Improve Problem Solving Skills and Creative Thinking Skills of Class XI Students

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ABSTRACT

The learning paradigm shift emphasizes the integration of 21st century skills into learning activities. SMAN 4 Malang as a driving school in Malang City has implemented Independent Curriculum in producing students who have the competence and character of the Pancasila Student Profile. The Pancasila Student Profile has relevance to the skills needed in the 21st century. Problem solving skills and creative thinking skills as dimensions of the Pancasila Student Profile are classified into the main abilities that students need to have to face the challenges of the 21st century. However, based on observations of problem-solving skills and creative thinking skills of students in class XI MIPA 3 are still low. Efforts can be made by implementing Problem-based Learning. This study aims to improve problem solving skills and creative thinking skills of XI grade students in Biology learning using Problem-Based Learning. This type of research is a Classroom Action Research which was conducted in two cycles. Each cycle includes planning, implementation, observation, and reflection stages. The research subjects were students of class XI MIPA 3 totaling 31 students. The research data in the form of qualitative data were reduced, grouped, and narrated. Quantitative data were analyzed descriptively inferentially using paired sample t test. The results showed a difference in the average problem-solving skills and creative thinking skills before and after PBL was applied, so this study proves that the application of PBL can improve students' problem-solving skills and creative thinking skills in Biology learning.

Keywords: *Problem-based learning, Problem solving skills, Creative thinking skills*

INTRODUCTION

Current education and curriculum reforms emphasize effectively integrating 21st century skills into varety of learning activities (Andrews-Todd & Forsyth, 2020). Education in the 21st century is characterized by a comprehensive interconnection of knowledge (Sudarisman, 2015) which is strongly influenced by globalization and internalization (de Leon-Abao et al., 2015). The 21st century generation has grown up in a rapidly digitalizing world (Boholano, 2017; Chiappe & Rodríguez, 2017) thus requiring individuals to have capabilities. Capabilities are a collection of more specific skills, procedures, and processes in utilizing resources towards competitive advantage (Baker & Sinkula, 2005). Capabilities possessed by learners are manifested in the skills possessed by learners.

The existence of the industrial revolution 4.0 also requires students to improve their capabilities. The industrial revolution is characterized by the importance of critical and

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creative thinking skills, leadership and entrepreneurship, the expansion of the digital world into people's lives, the development of artificial intelligence and big data technology. There are four competencies that learners must have in order to become capable learners and be able to compete in the 21st century, namely critical thinking and problem solving, creativity, communication skills, and the ability to work together (Sudrajat et al., 2020). Greenstein, (2012) also explains that in the 21st century there are 3 main abilities that need to be possessed, namely the ability to live in society; the ability to learn and innovate (including the ability to think critically, communicate, create, and collaborate); and information and technology skills.

Biology learning can be one of the alternatives in equipping 21st century skills (Zahra et al., 2023). Some studies in Biology such as human anatomy and physiology problems are Biology studies that contain complex problems that require problem solving skills in solving them (Bahri et al., 2018). In accordance with Phase F Learning Outcomes in Biology subjects, the circulatory system is material that requires a high cognitive level (Rahayu et al., 2022). Based on various complex studies in Biology content, it is necessary to emphasize the development of problem solving skills to be able to support the ability of students to formulate problems, prepare scientific steps, to determine problem solving steps, this is because students will face various challenges both now and in the future (Rahmawati et al., 2022).

Problem solving skills are the ability to identify problems, propose various solutions, and determine the right choice of solution based on the data obtained (Bariyyah, 2021). Researchers reveal that problem solving skills can positively affect the understanding of scientific concepts, creativity and logical thinking in overcoming problems, but the fact is that the problem-solving skills of students in secondary schools are still low (Chen et al., 2021). Problem solving skills are one of the indicators of intellectual behavior and higher-order thinking skills that need to be mastered by students (Akben, 2020). The level of problem-solving skills can be known through mastery of several problem-solving indicators. One of the indicators of problem-solving skills that can be used is the indicator developed by (Greenstein, 2012), including: 1) identifies the problem, 2) identifies solutions, 3) defends solutions (Greenstein, 2012).

The results of research conducted in several schools in Malang district show that students' problem-solving skills still need to be improved (Mahfudhillah et al., 2016). Similar problems were found in class XI MIPA 3 SMAN 4 Malang. The test results of problem-solving skills in students of class XI MIPA 3 were low, the percentage of problem identification indicators of 47%, the percentage of indicators of identification of various solutions of 47%, and the percentage of indicators of maintaining solutions of 45%. Furthermore, the average problem-solving skills obtained was 46%. These results are also supported by the results of research conducted in several schools in Malang district showing that students' problem-solving skills are still low (Rizky Abdillah et al., 2022).

Problem solving skills are closely related to the ability to generate innovative ideas, formulate new solutions, and express them with unique steps (Hobri et al., 2020a). Efforts to improve learners' problem-solving skills require creative thinking skills to develop solutive ideas in solving problems (Weninger, 2018). Another opinion also states that when learners want to solve problems, they need to use creative thinking skills to choose strategies, develop solutions, and consider the consequences of each solution (Bulut, 2019).

Creative thinking skills is a divergent pattern of realistic thinking skills that allows a person to connect problems from multiple perspectives and find unique solutions (Habibi et al., 2020). Creative thinking skills is important in the student learning process in helping to solve problems, generate ideas as new views and be able to argue in response to problems faced (Wiggins, 2020). The level of individual creative thinking skills can be known through

mastery of creative thinking skills indicators, such as those developed by Treffinger et al., (2002) namely: 1) fluency), 2) flexibility, 3) originality, 4) elaboration. The problem found in class XI MIPA 3 is that creative thinking skills are still low with test results showing the percentage of fluency indicators at 40%, the percentage of originality indicators at 44%, the percentage of flexibility indicators at 42%, and the percentage of detail indicators at 41%. Furthermore, the average of creative thinking skills is 42%.

The independent curriculum currently being implemented has relevance to the skills needed in the 21st century. Problem solving and creative thinking skills are included in one of the dimensions of the Pancasila Students Profile in the Independent Curriculum, namely the creative dimension. Creative students are able to validate and produce something original, meaningful, useful, and impactful (Kemendikbudristek, 2021). Through the driving school program, it encourages the process of educational transformation to improve the learning outcomes of students holistically from both cognitive and non-cognitive (character) competency aspects in order to realize the profile of Pancasila students (Kepmendikbudristek, 2021). As a driving school in Malang City, SMAN 4 Malang strives to prepare students who are capable of facing the challenges of the 21st century.

Efforts to overcome the problems that have been described are that teachers need to apply innovative learning. Research of Ndia & Sahidin, (2020) shows that the syntax in the learning model can determine the success of achieving learning objectives. One of the learning models that is widely adopted to support student centered learning and empower students' thinking skills is the Problem-based Learning (PBL). Problem-based Learning (PBL) is a learning model that focuses on problem solving process in collaboration in small groups. (Noordegraaf-Eelens et al., 2019). PBL encourages learners to be independent, prepares for long life learning, and requires students to learn actively and deeply (Siew et al., 2017).

PBL has advantages in improving learners' skills. According to Cheng et al., (2018) one of the advantages of PBL is that it can improve students' ability to determine various strategies in finding solutions to problems faced so as to create a meaningful learning environment. Several studies have shown that PBL can improve students' problem-solving skills (Barrett & Moore, 2010; Hestiana & Rosana, 2020; Kassymova et al., 2020) and help improve creative thinking skills (Siew et al., 2017). This study aims to improve solving skills and creative thinking skills through the application of Problem-based Learning model in Biology learning.

METHODS

This research was conducted during Educational Field Practice 1 activities in the first semester of November to December of the 2022/2023 school year. The research subjects were Phase F students, namely class XI MIPA 3 SMA Negeri 4 Malang, totaling 31 students including 20 girls and 11 boys. The research design used was a class action research model of Kemmis, McTaggart & Nixon, 2014. The model was chosen in this class action research, because the implementation of action activities; and observing as a stage that must be done in one unit of time, so it cannot be separated. The research was conducted in two cycles. Each cycle consisted of planning, implementation, observation and reflection stages Figure 1.

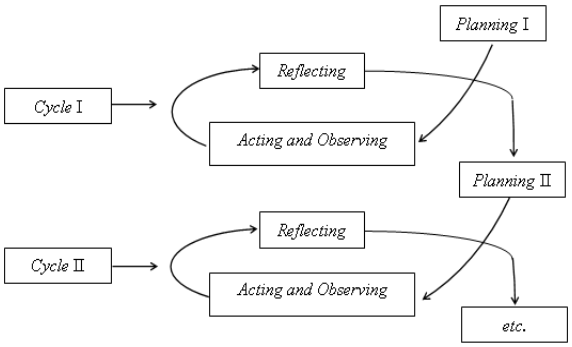

Figure 1. Class Action Research Cycle of Kemmis dan McTaggart Model (Asrori & Rusman, 2020)

Planning activities are carried out by conducting observation activities on learning strategies applied by teachers and student responses during the learning process. Analyzing the learning tools designed by the teacher. Identifying problems that occur during the implementation of learning. Conducting pre-cycle tests to measure problem solving skills and creative thinking skills of students. Designing solutions to overcome problems. Prepare learning tools with Problem-based Learning models that have been integrated with problem solving skills and creative thinking skills. The learning tools consist of teaching modules equipped with research instruments along with scoring rubrics, learning media, LKPD, diagnostic assessments, and learning implementation observation sheets.

Implementation activities are carried out by applying the PBL model in the learning process. The PBL syntax used is according to the PBL syntax according to (Arends, 2012) includes orienting students to the problem, organizing students to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process. Problem solving and creative thinking skills tests were conducted at the beginning and end of each cycle. Observation activities are carried out by recording and observing the implementation of learning using the learning implementation observation sheet by the observer. Reflection activities are carried out at the end of the cycle by determining the strengths and weaknesses of the learning that has been implemented. Evaluate and reflect together with student teachers and observers on the implementation of learning. The results of reflection and evaluation in cycle I were used as improvements in cycle II.

The data collection instruments used are pre-research interview guideline sheets for Biology education practitioners, observation sheets for learning activities, cognitive diagnostic assessments, problem solving skills tests equipped with a scoring rubric according to Greenstein, (2012) and the creative thinking skills test equipped with a scoring rubric according to Treffinger et al., (2002). Data collection techniques used are tests and non-tests. Data obtained from the test results, in the form of quantitative data, namely the test results of problem-solving skills and creative thinking skills tests. Data obtained from non-test results, namely pre-research interviews of Biology education practitioners, observation sheets of learning activities.

Quantitative data analysis techniques were analyzed using descriptive and inferential analysis techniques. Descriptive analysis was used to describe the test results of problem solving skills and creative thinking skills. Inferential analysis uses paired t-test to see whether there was a significant increase in problem solving skills and creative thinking skills in each cycle. While qualitative data analysis techniques include data reduction, data display, conclusion drawing and verification.

RESULTS AND DISCUSSION

Results

Problem Solving and Creative Thinking Skills

This class action research was conducted on 31 students of class XI MIPA 3 SMAN 4 Malang odd semester of 2022/2023 school year in Biology subject. Before entering cycle I, researchers conducted a pre-cycle test to determine the problem solving skills and creative thinking skills of students before applying the Problem-based Learning model. The results of this pre-cycle test were used as a cognitive diagnostic assessment of students. The completeness of the pre-cycle test results of problem-solving skills can be seen in Table 1.

Tabel 1. Completeness of Problem Solving and Creative Thinking Skills Pre-Cycle

Skills	Amount	Percentage	Completeness
Problem Solving	20	65%	Not Completed
	11	35%	Completed
Creative Thinking	21	68%	Not Completed
	10	32%	Completed

Based on the results of the classical completeness of the pre-cycle test in Table 1. it can be seen that out of 31 students, 20 students did not meet the criteria for completeness in the problem solving skills test and 11 other students met the criteria for completeness. So if converted in percentage form, 65% of students were not complete in the problem solving skills test and 35% of students were complete in the problem solving skills test. As for the results of the analysis of classical completeness of the creative thinking skills test, out of 31 students, 21 students have not met the criteria for completeness of the creative thinking skills test, and 10 other students have met the criteria for completeness of creative thinking skills. So that when conserving into a percentage form, 68% of students were not complete in the creative thinking skills test, and only 32% of students reached the completeness of the creative thinking skills test.

Problem Solving Skills in Cycle I and Cycle II

Data on the results of solving skills were obtained through a problem solving skills test which was tested before (pretest) and after (posttest) the implementation of the action by applying the Problem-based Learning model. The test instrument used has been adjusted to the indicators of problem solving skills by (Greenstein, 2012) including, 1) Identifies the problem, 2) Identifies several solutions, 3) Defends solutions. The data from the problem solving skills test were averaged and then presented in the form of a graph in Figure 2.

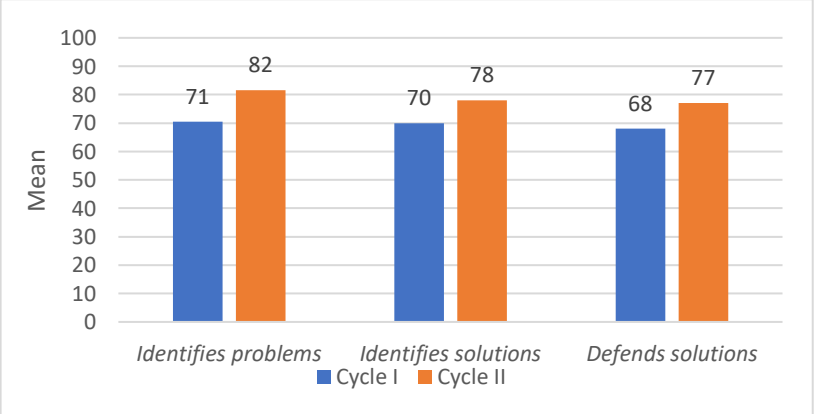

Figure 2. Problem Solving Skills Test Results

The graph in Figure 2 is a presentation of data from the problem-solving skills test results in cycle I and cycle II. Based on the data presented, it can be seen that the average score on the identifies problems indicator in cycle I was 71, in cycle II it increased to 82. The average score on the identifies solutions indicator in cycle I was 70, in cycle II it increased to 78. The average score on the defends solutions indicator in cycle I was 68 and increased to 77. From the graph, it can be seen that the problem-solving skills indicator has increased from cycle I of 70 to 79 in cycle II.

The data from the problem-solving skills test were then analyzed using paired t-test to see if there was a difference in the average results of problem-solving skills before and after applying the Problem-based Learning model. Before the paired t-test was conducted, the data was tested for normality using the One-Sample Kolmogorov-Smirnov Test. The purpose of the normality test is to determine whether the data is normally distributed so that it can determine what hypothesis test will be used. The results of the normality test of problem-solving skills data in cycle I and cycle II are shown in Table 3.

Table 3. Normality Test Results of Problem-Solving Skills

One-Sample Kolmogorov-Smirnov Test			
		Cycle I	Cycle II
N		31	31
Normal Parameters[a,b]	Mean	15.1290	19.7742
	Std. Deviation	7.77064	5.99839
Most Extreme Differences	Absolute	.100	.195
	Positive	.100	.195
	Negative	-.089	-.097
Kolmogorov-Smirnov Z		.558	1.084
Asymp. Sig. (2-tailed)		.915	.191

Table 3 shows the results of the normality test of problem-solving skills data where the Sig value. (2-tailed) 0.915 > 0.05 then the data is normally distributed. The results of the normality test of problem-solving skills data in cycle II show a Sig. (2-tailed) 0.191 > 0.05, so the data is normally distributed. Thus, the normality test of problem solving skills data in cycle I and cycle II is normally distributed, so the data can be analyzed using parametric tests, namely paired t tests. The results of the paired t test analysis of problem solving skills can be seen in Table 4.

Table 4. Paired t test results of Problem-Solving Skills Cycle I and Cycle II

Paired Samples Test				
Pair	Cycle	t	df	Sig. (2-tailed)
Pair 1	Cycle 1	-10.840	30	.000
Pair 2	Cycle 2	-18.355	30	.000

Table 4 shows that the Sig. (2-tailed) 0.000 <0.05, then H0 is rejected and Ha is accepted so that it can be concluded that there is a difference in the average test results of problem-solving skills before and after the application of the Problem-based Learning model in the first cycle. Furthermore, the results of data analysis in cycle II showed a Sig. (2-tailed) 0.000 <0.05, then H0 is rejected and Ha is accepted so that it can be concluded that there is an average difference in the results of the problem-solving skills test before and after the application of the Problem-based Learning model in cycle II.

Creative Thinking Skills in Cycle I and Cycle II

Data on the results of creative thinking skills were obtained through creative thinking skills tests tested before (pretest) and after (posttest) the implementation of the action by applying the Problem-based Learning model. The test instrument used has been adjusted to the indicators of problem solving skills by (Treffinger et al., 2002) including, 1) fluency, 2) flexibility, 3) originality, 4) elaboration. The data from the creative thinking skills test were averaged and then presented in the form of a graph in Figure 3.

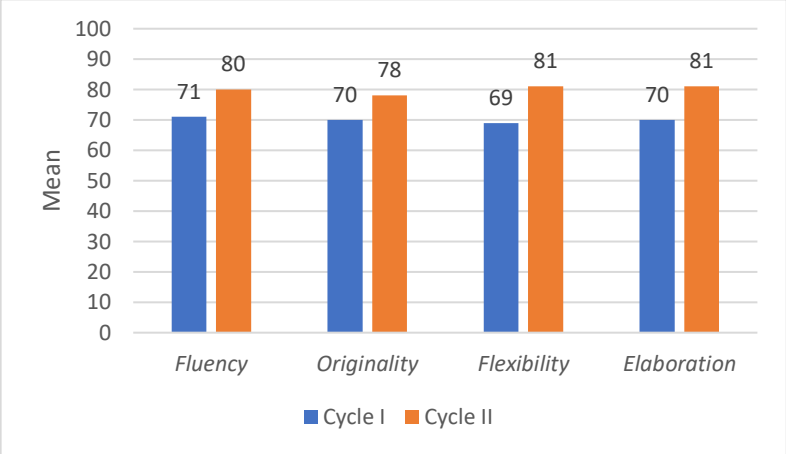

Figure 3. Creative Thinking Skills Test Results

Based on the graph presented in Figure 3, it can be seen that each indicator of creative thinking skills has increased from cycle I to cycle II. The average value of the fluency indicator in cycle I showed a value of 71 and increased to 80 in cycle II. The originality indicator in cycle I showed an average value of 70 and increased in cycle II to 78. The average value of the flexibility indicator in cycle I was 69 and increased to 81 in cycle II. The elaboration indicator in cycle I showed an average value of 70 and increased in cycle II to 81. So it can be concluded that the average value of creative thinking skills test results has increased from cycle I to cycle II.

The data from the creative thinking skills test were then analyzed using a paired t-test to see if there was a difference in the average results of creative thinking skills before and after applying the Problem-based Learning model in cycle I and cycle II. Before the paired t test was conducted, the data was tested for normality using the One-Sample Kolmogorov-Smirnov Test. Normality test is used to determine whether the data is normally distributed so that it can determine what hypothesis test will be used. The results of the normality test of creative thinking skills data in cycle I and cycle II are shown in Table 5.

Table 5. Normality Test Results of Creative Thinking Skills

One-Sample Kolmogorov-Smirnov Test			
		Cycle I	Cycle II
N		31	31
Normal Parameters[a,b]	Mean	15.7419	20.3226
	Std. Deviation	.7.35286	6.02985
Most Extreme Differences	Absolute	.110	.129
	Positive	.110	.129
	Negative	-.088	-.080
Kolmogorov-Smirnov Z		.611	.716
Asymp. Sig. (2-tailed)		.849	.685

Table 5 shows the results of the normality test for cycle I creative thinking skills data where the Sig value. (2-tailed) 0.849 > 0.05 then the data is normally distributed. The results of the normality test of creative thinking skills data in cycle II show a Sig. (2-tailed) 0.685 > 0.05, so the data is normally distributed. Thus, the normality test of creative thinking skills data in cycle I and cycle II is normally distributed, then the data is analyzed using parametric tests, namely paired t tests. The results of the paired t test analysis of creative thinking skills can be seen in Table 6.

Table 6. Paired T-test Results of Creative Thinking Skills

Paired Samples Test				
Pair	Cycle	t	df	Sig. (2-tailed)
Pair 1	Cycle 1	-10.840	30	.000
Pair 2	Cycle 2	-18.355	30	.000

Based on the results of the paired t test analysis of creative thinking skills in Table 6, the Sig. (2-tailed) cycle I of 0.000 <0.05, then H0 is rejected and Ha is accepted so it can be concluded that there is a difference in the average creative thinking skills before and after the application of the Problem-based Learning model in cycle I. Furthermore, the results of the analysis in cycle II show the Sig. Furthermore, the results of the analysis in cycle II showed a Sig. (2-tailed) 0.000 < 0.05, then H0 is rejected and Ha is accepted so it can be concluded that there is a difference in the average creative thinking skills before and after the application of the Problem-based Learning model.

Discussion

The research begins with the action planning stage, namely conducting observations and coordination with the cooperating teacher regarding the implementation of the action and the material to be used for the application of the Problem-based Learning model, preparing observation sheets for the implementation of learning by teachers and students, compiling learning tools consisting of teaching modules, assessment instruments along with scoring rubrics, and learning media. Proper learning planning can have a positive impact on students, including developing creativity, critical thinking, analytics and can improve the ability to construct new knowledge for students (Widyanto & Wahyuni, 2020). Planning activities are also carried out by carrying out pre-cycle tests as cognitive diagnostic assessments to determine the characteristics and needs of students. One of the challenges of implementing the Merdeka curriculum is the change in the assessment and evaluation system. Assessment in the independent curriculum prioritizes the diagnostic assessment process for cognitive and non-cognitive aspects (Supriyadi et al., 2022).

Based on the results of pre-cycle data analysis, 65% of students were not complete on the problem solving skills test, and 68% of students were not complete on the creative thinking skills test. The results of other studies also show that students' problem solving and creative thinking skills are still low (Suryadi et al., 2023). This is because students are accustomed to facing questions with low cognitive levels. In addition, students are not accustomed to discussing to solve problems and pouring creative ideas in solving problems and learning that tends to use the lecture method and assignments (Mandasari, 2016). Another external factor that affects the thinking ability of students is the learning process that does not encourage students to develop thinking skills where the learning process is directed to the child's ability to memorize information. Based on previous research, these problems can be overcome by applying learning models that accommodate students' thinking skills such as the Problem-based Learning model (Suwono et al., 2023).

Implementation activities are carried out by applying the Problem-based Learning

model and then recorded and observed by observers to measure the implementation of learning. The Problem-based Learning model was chosen because PBL is learning that emphasizes the process of involving students to analyze contextual problems and create relevant solutions to minimize these problems (Jenah et al., 2022; Nasution et al., 2018). The Problem-based Learning model also encourages students to be able to construct their own knowledge, foster skills, and increase students' confidence (Janah et al., 2018). The results of the meta-analysis research show that the Problem-based Learning model can improve students' problem solving skills and creative thinking skills in Biology learning (Nursal & Alberida, 2023).

Application of Problem-based Learning Model to Improve Problem Solving Skills

The results of the calculation of the average problem solving skills in **Figure 2** show an increase in problem solving skills from cycle I to cycle II. Furthermore, from the results of the paired t test analysis in Table 3, the Sig. (2-tailed) 0.000 < 0.05, it can be said that there is a difference in the average problem solving skills before and after the application of PBL in cycle I and cycle II. This finding supports the results of previous studies which prove that the PBL learning model has a significant effect and can improve problem solving skills (Afwah et al., 2023; Ernawati, 2017; Harris & Hofer, 2011).

The improvement of students' problem solving skills is based on students' understanding of the circulatory system material for the better. This is because PBL syntax provides contextual problems so that it can facilitate students' understanding of Biology learning materials (Wulandari, 2011). The application of PBL accommodates students to learn through real-world problems as a context for students to learn to acquire essential knowledge and concepts of human physiology material (Wulandari, 2011). The essential concepts in the material are taught through the learning steps in the syntax of Problem-based Learning.

The stage of orienting students to the problem supports the problem identification indicator. Learning activities at this stage students identify problems from the phenomena given by making problem formulations. Learners are also trained to identify problems through providing phenomena in problem orientation activities integrated in LKPD. Teaching materials integrated with problem solving accommodate students to learn to do problem solving (Ilmi et al., 2019).

Another study also explained that when learners formulate questions, students are encouraged to formulate scientific arguments about the chosen topic and determine the problems that arise based on the phenomena seen (Kundariati et al., 2021). Higher-order thinking skills will be active when a person is faced with a problem, statement, uncertainty, or dilemma (Kundariati et al., 2022). The next activity is group inquiry where this stage involves a series of reference review processes that support the construction of solution identification (Chang & Tung, 2009). Exploration activities are required at this stage. Exploration is used to build problem solving ideas by reading relevant references, so exploration activities involve a system of inquiry that relies on empirical evidence to understand, describe, predict, and provide solutions to problems (Hobri et al., 2020b). The stage of presenting the results, analyzing and evaluating the results of problem solving can accommodate the indicator of maintaining the solution. At this stage, students and teachers evaluate together whether the formulation of the problem or the chosen solution is correct or not. Evaluation activities can make students' problem solving skills better (Özreçberoğlu & Çağanağa, 2018).

Application of Problem-based Learning Model to Improve Creative Thinking Skills

Based on the results of the calculation of the average creative thinking skills in **Figure 3**, it shows an increase in creative thinking skills from cycle I to cycle II. Furthermore, from

the results of the paired t test analysis in Table 6, the Sig. (2-tailed) 0.000 < 0.05, it can be said that there is a difference in the average creative thinking skills before and after the application of PBL in cycle I and cycle II. These findings corroborate previous research that creative thinking skills can be improved through the implementation of PBL models that can train students to be active during learning (Tendrita et al., 2016). Some related studies suggest that creative thinking skills can be improved through the implementation of innovative learning models that can train students to be active during learning (Ketabi et al., 2012; Suprapto et al., 2017). During the implementation of PBL, the teacher acts as a facilitator who guides and directs student activities or as a scaffolder (Syarifah et al., 2016). Learning with the main focus on real problems in students' lives, where students as problem solvers and teachers as facilitators will be more optimal in directing students to achieve higher levels of creative thinking skills (Barbot et al., 2011).

PBL learning begins with problem orientation to learners. Learners' ability to generate ideas (fluency) begins to be trained at this stage. This activity directs learners to generate ideas, and create solutions to problems presented by the teacher. Through PBL, learners get the opportunity to participate in solving real problems, knowledge construction is done through an authentic context (Guo et al., 2021). The next stage organizes students to learn. At this stage it directs students to make questions as problem formulations. Activities at this stage are believed to trigger cognitive conflict between students' initial understanding and the concepts that students have just received. Through some of the questions that students have made, we will see a picture of students' understanding of the learning material will be seen, compared to only reading factual information provided in learning resources (Murni, 2018). Previous research shows that the questioning stage is an activity that has high value, especially in creative thinking skills (Rovers et al., 2018). The group investigation stage trains learners to investigate the problems they found in the previous stage. Investigation activities support the formation of learners' ability to generate a number of ideas, suggest different alternative solutions that are logical and relevant to the given problem, generate interesting and relatively new unique ideas according to the given problem, and train the ability to organize ideas in detail into a more complete solution.

Based on the findings and discussion of the application of the PBL model is proven to be able to improve problem solving skills and creative thinking skills of students in learning Biology. However, this study also has limitations, namely researchers have not considered the weaknesses in the PBL model, namely assessing student learning outcomes which tend to be done at the end (summative) so that this study has not implemented formative assessment to measure students' learning progress. Therefore, it is necessary to integrate formative assessment into PBL to assess student learning progress in an effort to improve learning outcomes through feedback.

CONCLUSION

Based on the results of class action research that has been conducted, it can be concluded that the application of Problem-based Learning model can improve problem solving skills and creative thinking skills of students of class XI MIPA 3 SMAN 4 Malang in Biology learning. The calculation of the average value of the problem solving skills test in cycle I amounted to 70 and increased to 80 in cycle II. Calculation of the average value of creative thinking skills in cycle I of 70 increased to 79 in cycle II. These results show an increase in the average value from cycle I to cycle II. In addition, it is supported by the results of the paired t test which shows a difference in the average problem solving skills and creative thinking skills before and after applying the PBL learning model in cycle I and cycle II. The implication of this study is that the application of the Problem-based Learning model

can improve students' 21st century skills such as problem solving skills, creative thinking, critical thinking, through the process of communication and collaboration in solving real-world problems. The results of this study can be a reference for future researchers to carry out research by exploring further related to the application of the Problem-based Learning model by considering the shortcomings of the model, so that it is expected to be information and recommendations for appropriate learning strategies for educators.

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