RESEARCH ARTICLE

Improving critical thinking and creative thinking skills through POPBL learning in high school student

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Abstract: Education in the 21st century has experienced many advances that are adjusted to the demands of the times. Thinking skills are in high demand in the 21st century, especially critical thinking and creative thinking skills for students. This study aims to determine the effectiveness of POPBL model learning in improving critical and creative thinking skills of high school students. This type of quasi-experimental research was carried out with a nonequivalent control group design. The population of this study was students of class XI MIPA SMAN 1 Cluring with two classes XI MIPA 1 and XI MIPA 2 as samples. The data collection method is in the form of tests of critical thinking skills and creative thinking. The data analysis used is an analysis of covariance test. The results showed that POPBL was effective in improving the critical thinking and creative thinking skills of SMAN 1 Cluring students. The implementation of POPBL learning shows interaction between students at work as well.

Keywords: creative thinking skills; critical thinking skills; POPBL; problem-oriented project-based learning model

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Introduction

Education in the 21st century has experienced many advances that are adjusted to the demands of the times. The learning process emphasizes mastering 21st century life skills including cognitive abilities and interpersonal skills (Haug, 2021; Sarwanto et al., 2021). The cognitive realm includes skills in thinking, namely critical thinking skills, and creative thinking (Huerta et al., 2022), While interpersonal skills consist of collaboration, cooperation and communication skills (Haug, 2021; Nir, 2016). Therefore, the learning carried out must be able to help empower critical thinking and creative thinking skills (Albar & Southcott, 2021). Critical thinking and creative thinking skills are part of The Partnership for 21st Century Skills and are recognized as core competencies to prepare students for advancement in the world of work (Alharbi, 2022; Alharbi et al., 2022). Thinking skills are in high demand in the 21st century, especially critical thinking and creative thinking skills for students.

Students who have critical thinking skills are usually able to analyze problems specifically, in detail, and be careful when making decisions. Critical thinking skills are essential foundational skills in problem solving to find the right solution (Supena et al., 2021). Critical thinking skills are the ability to analyze, interpret, evaluate, summarize, and synthesize all information and be able to apply the results to solve problems (Trilling & Fadel, 2009). Students who are accustomed to critical thinking will respond to everything critically by filtering it through a mature thinking process. The importance of critical thinking for students will help students to be able to focus on making conclusions, evaluating the results of analysis, events and events (Umrzokova & Pardaeva, 2020). Critical thinking skills can be empowered through the learning process. Students who can think critically well will also form a creative mindset.

Students who have creative thinking skills will appear more enthusiastic and active in finding new ideas to solve problems during learning activities. Creative thinking skills are skills to think of new ideas so that they can bring up something that has never been done (Atmojo & Sajidan, 2020). Creative thinking skills are essential to master in the 21st century. Students who can think creatively will find it easy to adapt to

changing times (Gu et al., 2019). Creative thinking skills enable problem-solving in various fields and come up with quality innovative and original solutions (Atun & Latupeirisa, 2021; Mursid et al., 2022). Creative thinking can be empowered through the learning process in schools. The application of appropriate models such as problem-based and project-based learning models can help empower students' creative thinking skills (Albar & Southcott, 2021). An appropriate learning model when applied in learning will help in developing students' thinking skills.

But in fact, students' critical thinking and creative thinking skills are still not optimal. This is reinforced by the results of previous research related to the measurement of students' critical thinking skills which stated that it was still relatively low (Anwar et al., 2020). This is supported by research results using the Problem Posing or Contextual Learning model (Toheri et al., 2020), PJBL (Sumarni & Kadarwati, 2020; Wulansari et al., 2019), PBL and blended learning (Yennita & Zukmadini, 2021), What is applied has not been able to empower critical and creative thinking skills optimally. These critical thinking and creative thinking skills are interrelated cognitive abilities (Siburian et al., 2019). The results of the preliminary study at SMAN 1 Cluring using tests of critical thinking skills and creative thinking with an average score of 58.46% show that students' critical thinking and creative thinking skills are included in the low category and need to be optimized. Therefore, this proves that SMAN 1 Cluring students need to improve critical thinking and creative thinking skills. This exposure is the reason that underlies SMAN 1 Cluring being used as a place of research.

Efforts to develop thinking skills educators can apply learning models that are able to train thinking skills in biology learning. Critical thinking and creative thinking skills have a mutually supportive relationship from all aspects such as mastery of concepts and problem solving (Amanda et al., 2022; Khotimah et al., 2021; Siburian et al., 2019). But in reality, the learning model carried out is still unable to improve critical thinking and creative thinking skills. Research by Lendeon and Poluakan, (2020) states that learning using conventional models makes students bored because learning is only teacher-centered. The results of previous research using the POPBL model can only improve communication and teamwork, while the ability to think has not focused on being studied (Latada & Kassim, 2017). Therefore, based on these problems, a problem-based and project-based learning or called Problem Oriented Project Based Learning (POPBL) will be prepared which is used to measure students' critical thinking and creative thinking skills.

The POPBL model is problem-oriented as well as project-based learning (Setiarini & Wulan, 2021). The POPBL model is a project-based learning pattern oriented to solving a problem (Yasin & Rahman, 2011). The POPBL model is one of the constructivist learning models that is very appropriate to be used in this era because in addition to improving 21st century skills, it can also develop student competencies (Ibrahim & Halim, 2013). The POPBL model emphasizes three principle theories of learning including cognitive learning, collaborative learning and content (Latada & Kassim, 2017). The application of problem-based learning and projects is in line with the existence of an independent curriculum which is expected with the implementation of projects students can develop their skills and potential (Saraswati et al., 2022). Research examining the effect of implementing POBL on students' thinking skills has been carried out in several previous studies. Research in Sumbawa developed learning that integrated POPBL with STAD to improve students' creative thinking skills (Supratman et al., 2020) while other research has integrated SR-STEM in the POPBL model to measure students' critical thinking skills (Rizki & Suprapto, 2024). Other research has developed test instruments to measure the thinking skills of students who follow this learning model (Muhajir et al., 2019). In Malang, this model has also been studied involving creative thinking as the dependent variable (Francisco et al., 2024). However, research that measures critical and creative thinking skills in students taking POPBL is still difficult to conduct. Therefore, this study aims to determine the effectiveness of learning the POPBL model in improving students' critical and creative thinking skills.

Method

This research includes quantitative research with the type of research used, namely quasi-experiment. The research design used Nonequivalent Control Group Design. In this study, there were control classes and experimental classes. The experimental class is a class taught with the POPBL model and the control class is taught with a conventional model. The study was conducted in August until September 2022. Research was conducted on two materials, namely plant tissue structure material and animal tissue structure. The research was conducted at SMAN 1 Cluring in class XI MIPA.

The population of this study was all students of XI MIPA SMAN 1 Cluring which amounted to 175. The research sample was 70 students of grade XI MIPA 1 and XI MIPA 2 SMAN 1 Cluring Banyuwangi. The sampling technique uses simple random sampling through a class equality test in which every member of the population has an equal opportunity to be selected (Leddy & Ormrod, 2018). The equivalence test using the Anava test was then carried out further Tukey tests to determine the difference in the average scores in each class.

The instrument used in this study was in the form of critical and creative thinking skills test questions in

the form of descriptions totaling 10 questions. This study also used POPBL learning tools which include learning objectives flows and teaching modules containing handouts, student worksheets, and critical thinking and creative thinking skills test instruments. POPBL learning tools that have been developed are then validated by learning expert validators, learning practitioners, and material experts.
The research and development model that will be used in developing tools in the POPBL learning model, namely from the model of ADDIE development, The ADDIE development model has five stages, according to Branch, (2009), namely: analyze, design, develop, implement, and evaluate. Based on the results of the validation that has been done, the POPBL learning tool has been declared valid. The results of learning device validation include the Learning Objective Flow, teaching modules, handouts, Student Worksheets, and question instruments in Table 1.

Table 1. POPBL Learning Device Validation Results

Learning Tools	SMAN 1 Cluring	Information
Learning Objective Flow %	97.20	Very valid
Teaching Module%	93.46	Very valid
Handout%	94.79	Very valid
Student Worksheet %	97.06	Very valid
Instrument%	97.66	Very valid

In Table 1. The results of the validation of learning tools that have been made including the flow of learning objectives, teaching modules, handouts, student worksheets and question instruments show that they are declared very valid and suitable for use in POPBL learning. Question instruments can also be used to measure students' critical thinking and creative thinking skills.
The data collection techniques used are critical thinking skills and creative thinking skills. The test questions are in the form of descriptions totalling 10 items consisting of 6 critical thinking questions and 4 creative thinking questions. The test consists of two stages, namely the initial test carried out before learning biology on plant tissue structure material and the final test carried out at the end of animal tissue structure material. The implementation of tests in experimental and control classes is accompanied by biology teachers.
The data obtained were then tested for normality using one sample Kolmogorov Smirnov. The data is declared normal if the significance value > a value of α 0.05 then after the data is declared normally distributed, the homogeneity test is continued using the Levene Test of Equality of Error Variances, the data is declared homogeneous if the significance value > the value of α 0.05. Then after the data was declared normal and homogeneous, a hypothesis test was carried out using analysis of Covariance (ANCOVA) using SPSS software.

Results and Discussion

The critical thinking skills data obtained are then carried out prerequisite tests including normality and homogeneity tests. The results of the normality and homogeneity test are presented in Table 2. Based on the results of the normality test in the Table. 2 on students' critical thinking skills, showing that critical thinking skills data are otherwise normally distributed. The results of one sample analysis Kolmogorov-Smirnov obtained the value of Asymp sig. (2-tailed) = 0.180>0.05 can be interpreted that the distribution of critical thinking skills data is normally distributed and not deviated. Then after the data is declared normally distributed, it can be continued with the next test. Based on the results of the homogeneity test using Levene's Test of Equality of Error Variances in Table 2. Data on critical thinking skills were homogeneous with scores (Levene's test 0.888>0.05). Then continue to test the hypothesis using ANCOVA in Table 3.

Table 2. Normality and homogeneity test results of critical thinking skills

Class	Mean	Std. Deviation	N	*Asymp.Sig* (0.200)	*Levene's* Test. Sig
Experiment	67.06	12.822	35	0.180	0.888
Control	60.46	12.538	35		

Based on the results of the covariance analysis test, it is known that the p value of level 0.033< the value of α = 0.05, then H0 is rejected, thus there are differences in critical thinking skills in the experimental class taught with the POPBL model and the control class using the conventional model. Based on the results of the study showed that the POPBL model is effective in improving students' critical thinking skills. The results of this study are similar to previous research which showed that there was an increase

in students' critical thinking skills applied to the POPBL model (Ibrahim & Halim, 2013; Supratman et al., 2021).

Table 3. ANCOVA results for critical thinking skills data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	762.300[a]	1	762.300	4.741	.033	.065
Intercept	284548.129	1	284548.129	1769.550	.000	.963
Class	762.300	1	762.300	4.741	.033	.065
Error	10934.571	68	160.803			
Total	296245.000	70				
Corrected Total	11696.871	69				
R Squared = .065 (Adjusted R Squared = .051)						

The increase in students' critical thinking skills is because each phase of learning in the POPBL model can affect indicators of critical thinking skills. The POPBL Learning Model emphasizes three principles of learning including cognitive learning, collaborative learning and concepts (Latada & Kassim, 2017). This POPBL learning model has four phases including 1) orientation and problem formulation, 2) organizing learners to learn 3) designing and implementing projects 4) presenting project results and evaluation (Rongbutsri, 2017; Yasin & Rahman, 2011).

The first syntax of the POBPL model, namely in orienting and formulating problems, can improve critical thinking indicators, namely focus and reason. Students when thinking critically will focus on making essential questions (Kanmaz, 2022). POPBL learning can encourage students to think critically in identification and problem-solving activities (Supratman et al., 2021). Critical thinking skills can also train students to be able to make logical reasoning involving deductive reasoning to seek the truth of information (Alharbi, 2022). This phase is in accordance with the theory of cognitivism that learning will be meaningful if in the learning process students acquire new knowledge, participate and play an active role in identifying and understanding the concepts of the material being studied (Sundari & Fauziati, 2021).

The second phase of organizing students to learn in this phase will increase inference indicators, namely students are able to make conclusions logically and precisely from the results of the discussion of the information obtained. This statement is supported by the sociocultural theory of learning by Vygotsky (Hyun et al., 2020). Furthermore, the third phase of designing and implementing the project can improve situation indicators. Here students and groups can design solutions to problems in the selected surrounding environment. This statement is in accordance with the constructivist theory of learning by J. Bruner (Stapleton & Stefaniak, 2019). The fourth phase of the POPBL model, which is presenting and evaluating project results, in this phase will improve critical thinking indicators, namely clarity and overview, namely being able to review the decisions made. This statement is supported by the sociocultural theory of learning by Vygotsky which states learning is forming mental phases and increasing the student's zone of proximal development (Nurdyansayah & Fahyuni, 2016). These critical thinking skills are also related to creative thinking skills (Siburian et al., 2019). The results of data analysis of creative thinking skills that have been obtained are then carried out prerequisite tests including normality and homogeneity tests. The following are the results of the normality and homogeneity test in the Table. 4.

Table 4. Normality and homogeneity test results of creative thinking skills

Class	Mean	Std. Deviation	N	Asymp.Sig (0.200)	Levene's Test. Sig
Experiment	69.77	13.981	35	0.066	0.082
Control	60.29	10.425	35		

Based on the results of the normality test in the Table. 4 on students' creative thinking skills, showing that creative thinking skills data are expressed as normally distributed. The results of the Kolmogorov-Smirnov One Sample analysis obtained the value of Asymp sig. (2-tailed) = 0.180>0.05 can be interpreted that the distribution of data on creative thinking skills is normally distributed and does not deviate. Then after the data is declared normally distributed, it can be continued with the next test. Based on the results of the homogeneity test using Levene's Test of Equality of Error Variances in Table 4. Creative data is expressed homogeneously with values (levene's test 0.888>0.05). Then continued the hypothesis test using ANCOVA in Table 5.

Based on the results of the covariance analysis test in Table 5. It is known that the p value of level 0.002< the value of α = 0.05 then H0 is rejected thus there are differences in creative thinking skills in the experimental class taught with the POPBL model and the control class using the conventional model.

The indicators on each creative thinking skill also increased. The results of this study are in line with research that problem-based learning and projects can improve creative thinking skills (Supratman et al., 2021; Utami et al., 2015; Winarno et al., 2017). The syntax in the POPBL model is very helpful for improving every indicator of creative thinking skills (Fadhil et al., 2021).

Table 5. ANCOVA results for creative thinking skills data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	1574.629[a]	1	1574.629	10.354	.002	.132
Intercept	296010.057	1	296010.057	1946.434	.000	.966
Class	1574.629	1	1574.629	10.354	.002	.132
Error	10341.314	68	152.078			
Total	307926.000	70				
Corrected total	11915.943	69				
R squared = .132 (adjusted r squared = .119)						

The first phase that students do is orientation and problem formulation. At this stage it will help students to improve indicators of creative thinking skills, namely fluency where students must think directly in making their own ideas. The selection of essential problems must be considered because to provide solutions to agreed problems, questions designed to stimulate students' thinking to create various ideas so as to improve aspects of fluency (Yustina et al., 2022). The problems chosen by students are problems that exist in the surrounding environment. The results of research by Maor et al.,(2023) state that projects carried out based on problems from the surrounding environment have a relationship with students' creative, critical, and metacognitive thinking. Science learning is closely related to the creative process and does not focus on one method but uses different scientific learning (Quinn et al., 2012). The second phase organizes students to learn. This phase will help students develop flexibility indicators. Students in groups explore knowledge to understand the basic concepts related to problems related to the material through various learning resources (reading modules, textbooks, seeking information from various sources, including the internet), and write the results in the form of a summary or concept map. This phase is in line with Jean Piaget's theory which states that students will structure their knowledge after understanding concepts through various learning sources (Amineh & Asl, 2015).

The third phase is designing and implementing the project. This phase asks students to think originally in compiling ideas which are included in the indicator of creative thinking skills, namely originality. In groups, students discuss composing a project plan, which includes: project topic, goals and objectives, methods or ways of working, and expected results. then implement the project with direction and guidance from the teacher. Project work can continue outside of lessons according to each situation and condition. In working on the project, efforts are made to collaborate with proportional sharing. This is in line with research Yustina et al., (2022) which states the originality indicator is designed so that students can have opinions and structure ideas based on their own thoughts. The fourth phase presents and evaluates the results of the project. Together with groups of students, collaboratively present project results in various forms of creativity (posters, videos, application designs, action plans, etc.). Then students present the results of the project in various forms or ways in turns according to the teacher's direction. When a group presents, an evaluation process is carried out by the teacher and other students. This phase helps students improve indicators of creative thinking, namely elaboration, which is detailing ideas or ideas made. Problem and project-based learning are recognized as the most suitable methods for training students' creative thinking skills. The results of this research are in line with previous research regarding problem and project based learning models that are applied to students, which are very helpful in generating creative thinking skills (Albar & Southcott, 2021; Kuo et al., 2019; Pan et al., 2023). One of the principles of the POPBL model is to prioritize group work, social skills and skills in delivering product results (Yasin & Rahman, 2011). This learning model emphasizes interaction between students in work and discussion activities related to solutions or projects through solving the problems faced. This statement is supported by the sociocultural theory of learning by Vygotsky which states learning is building a higher mental phase that occurs when interactions generally occur when working together (Nurdyansayah & Fahyuni, 2016)

Conclusion

Based on the results of the analysis and discussion that have been described, it can be concluded that learning using the Problem Oriented Project Based Learning (POPBL) model is effective in improving critical thinking skills and creative thinking skills of SMAN 1 Cluring students. In POPBL learning, interaction between students can be seen in the process, as well as discussion activities related to solutions or projects through solving the problems they face. Recommendations for further research

related to the POPBL model can be carried out with other 21st century skills in order to broaden readers' information and insight regarding the benefits of this learning model.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

R. Suwistika: conducting the research, collecting data, writing the original article, revision; **I. Ibrohim:** methodology & review; and **H. Susanto:** review and editing.

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