

PBL in Blended Learning Design to Increase Critical Thinking and Problem-Solving Skills

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Abstract: This study explores how PBL integrated into blended learning affects the enhancement of critical thinking and problem-solving skills among senior high school students. It employs a quasi-experimental design involving a non-equivalent pretest-posttest control group. Participants consist of students from class X-5 assigned to the experimental group and students from class X-8 assigned to the control group. Data were collected using a validated description test to measure critical thinking and problem-solving skills. Analysis involved MANOVA, N-Gain calculation, and the Pearson correlation test. Findings indicate that implementing PBL in blended learning effectively improves critical thinking and problem-solving abilities. The experimental group's average post-test score for critical thinking was 85.83, compared to 75.42 in the control group, and for problem-solving, it was 85.56, compared to 71.67 in the control group.

Keywords: Critical thinking skills; PBL in blended learning; Problem-solving

Introduction

Education is confronted with the challenges posed by 21st-century learning. Today's generation must acquire 21st-century skills, which typically encompass critical thinking, creative abilities, communication and collaboration skills, problem-solving capabilities, and proficiency in science and technology (Permendikbud, 2016). The ability to create education that can participate in producing competent thinker resources like the world community in the 21st century is a challenge for teachers and other education personnel (Wijaya et al., 2016). The impact of the globalization era also affects the implementation of education so that education is expected to be able to produce student outcomes that are able to use life skills (Ardelia et al., 2021). The development of the times that have changed quite rapidly has also influenced various fields including education and technology. Incorporating technology into the biology learning process offers ease, making learning more effective, efficient, and practical (Yustina

et al., 2020). Education no longer runs conventionally but already uses communication and information technology devices (Wheeler et al., 2005).

In school learning activities, the learning process involves both teachers and students (Trilling et al., 2010). The ability to create education that can participate in producing competent thinker resources like the world community in the 21st century is a challenge for teachers and other education personnel (Wijaya et al., 2016). Technological developments in the 21st century increasingly make it easier for everyone to share and receive information related to various things, but the problem that occurs in the digital era society is the wrong use of ICT by certain individuals to spread hoax news (Setiawan, 2018). One solution to overcome is to teach individuals to think critically in responding to existing news by processing, observing and analyzing before receiving the information (Rachmantika et al., 2019).

The innovation implemented to improve students' learning ability is blended learning (Banila et al., 2021).

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Blended learning is a modern teaching alternative suitable for the era of globalization, allowing access anytime and anywhere while still incorporating face-to-face sessions (Badriyah et al., 2021). This method combines traditional classroom learning with online education (Melati et al., 2021). After the COVID-19 pandemic, blended learning has emerged as a solution to the limitations of exclusive face-to-face instruction (Nofiana et al., 2022). Online learning can be innovative learning model for student interaction through critical thinking skills that support the learning process (Arends, 2012).

Problem-based learning is an effective model to integrate with blended learning (Garrison et al., 2004). This approach enhances students' ability to solve problems they encounter (Zulfa et al., 2022). The PBL model has characteristics that show that the problem-centered learning presented refers to authentic problems, information is obtained independently and the teacher is a facilitator (Fitriani et al., 2022). Blended-PBL enhances students' understanding and knowledge while also offering a learning environment that helps them find solutions to problems using various internet resources (Yu et al., 2015). Blended learning is an opportunity to integrate advances the innovation and technology made with online learning and conventional learning (Bakrie, 2021). Blended learning a trend in education with a better approach because it views learning as a continuous process that allows students to learn independently at home (Dziuban et al., 2018).

Implementing blended learning with problem-based learning in the biology classroom requires technological support from both students and the school (Castro, 2019). Blended learning is characterized by live synchronous, virtual synchronous, collaborative asynchronous, and independent asynchronous learning spaces (Borup et al., 2019). The use of various online learning platforms facilitates PBL within blended learning (Santosa et al., 2023). Specifically, integrating problem-based learning in blended learning with the Google Sites platform fosters more effective learning activities, guided by teachers as communication facilitators (Alfionora et al., 2022). The study of biology should be associated with benefits in everyday life. Environmental change is the material that will be used in this study because it is related to environmental problems (Fatmawati et al., 2021). Students' learning experiences with environmental change topics should be connected to real-world issues and involve scientific investigation to enhance their problem-solving abilities (Rabacal, 2018). Learning goals should be developed to enhance critical thinking and problem-solving abilities, crucial for understanding the findings of research in biology-related fields (Wahyuni et al., 2020).

Building upon the aforementioned context, this research aims to assess the efficacy of PBL within blended learning in improving critical thinking and problem-solving skills among high school students.

Method

This quantitative research employing a quasi-experimental design encompasses various stages, such as problem definition, objective setting, brainstorming, experiment design, experiment implementation, data collection, data analysis, result interpretation, and outcome validation.

Research Design

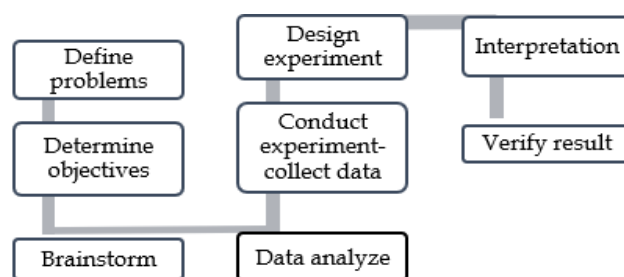


Figure 1. Quasi experiment design

The selected research methodology is a non-equivalent pretest-posttest control group design. The intended research design is outlined in Table 1 provided below.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Ec	O ₁	X ₁	O ₂
Cc	O ₃	X ₂	O ₄

Description:

- Ec : Experiment Class
- Cc : Control Class
- O₁ : Pretest experiment
- O₂ : Posttest experiment
- O₃ : Pretest control
- O₄ : Posttest control
- X₁ : PBL with Blended learning
- X₂ : Discovery Learning

Population and Samples

The study population included all students in Class X at Senior High School 1 Kasihan. Cluster random sampling was used to select the sample, with Class X-5 assigned as the experimental group and Class X-8 as the control group.

Instruments

The instruments of data collection in this research included a description test of critical thinking skills and problem-solving previously validated by experts and validated empirically

Data Analysis Techniques

Data analysis in this study commenced upon the initiation of data collection and continued until its completion. The data underwent analysis through Multivariate Analysis of Variance (MANOVA), N-Gain calculation, and the Pearson correlation test.

Result and Discussion

The study took place at SMAN 1 Kasihan Bantul. The experimental group displayed a higher average post-test score for critical thinking skills, recording 85.83 compared to the control group's 75.42. Additionally, the average N-Gain score in the experimental group was 0.7, whereas it was 0.4 in the control group. Similarly, regarding problem-solving skills, the experimental group achieved an average post-test score of 85.56, surpassing the control group's 71.67. The average N-Gain score in the experimental group was 0.7, compared to 0.4 in the control group. Further elaboration can be found in the N-Gain diagram, which depicts the critical thinking and problem-solving skills of students in both the experimental and control groups.

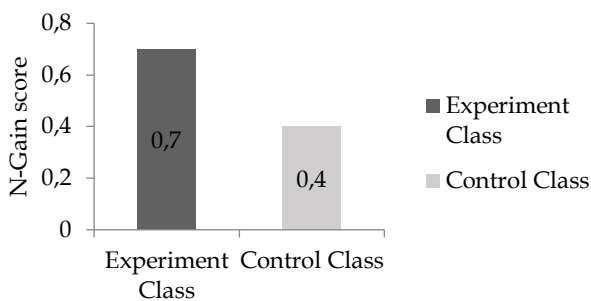


Figure 2. N-Gain score critical thinking skills

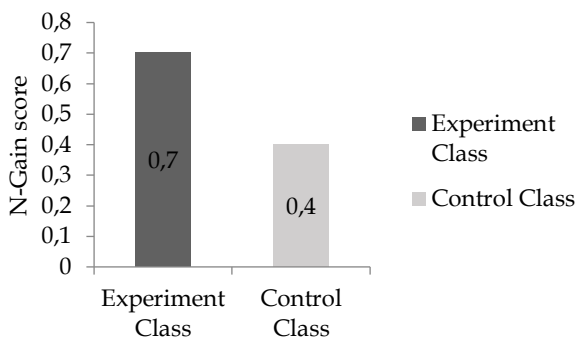


Figure 3. N-Gain score problem solving

The MANOVA test results revealed a significance value of 0.000, falling below the threshold of 0.05 ($0.000 < 0.05$), signifying that the integration of PBL in blended learning impacts students' critical thinking and problem-solving skills concerning environmental change material. This influence is likely due to the utilization of PBL in blended learning, specifically through the Google Sites online platform, which enhances learning resources and enriches information on environmental change material by providing additional materials, images, and educational videos (Yulia et al., 2023). The adoption of Blended-PBL in biology education demonstrates positive engagement and satisfactory responses during PBL-based blended learning activities, surpassing conventional methods in enhancing critical thinking and problem-solving skills (Habibah et al., 2022).

Table 2. Multivariate Analysis of Variance Test

Effect	Value	F Hypothesis	df	Error df	Sig
Pillai's trace	.83	33.28	6000	280.000	0.000
Wilks lambda	.18	63.08	6000	278.000	0.000
Hotelling's trace	.45	103.74	6000	276.000	0.000
Roy's largest root	.45	209.80	3000	140.000	0.000

Combining PBL with online education enhances motivation, scientific communication, and higher-order thinking abilities, leading to improved student performance in biology and the successful attainment of 21st-century learning objectives (Suwono et al., 2019). The steps in PBL learning in blended learning use face to face virtual synchronous so that students can interact with the teacher directly and students can still access the Google Sites online platform for learning activities (Murawski, 2000). As stated by Izzati et al. (2021), employing blended learning approaches (both online and offline) proves effective, as it enables students to access educational resources at their convenience and augment teacher-provided materials through self-directed learning.



Figure 4. Students during blended learning

The correlation test findings between students' critical thinking and problem-solving abilities demonstrate a strong and positive association in the application of PBL within blended learning. This is corroborated by the Pearson correlation test result, which has a significance level of 0.000, indicating statistical significance at a level below 0.05 ($0.000 < 0.05$). Interpretation of the two dependent variables reveals a strong correlation, with a Pearson correlation coefficient of 0.730, falling within the strong category; indicating that higher critical thinking abilities correspond to higher problem-solving skills. Blended learning holds significance in the school learning process as it positively influences students' critical thinking skills (Kinay et al., 2016). Saputri advocates for the incorporation of critical thinking skills in science education (Saputri et al., 2017). Critical thinking can taught and in a targeted manner to prepare students to face future by carrying out exercises and evaluating and testing ideas that come out during learning process (Gultom et al., 2022).

Table 3. Pearson Correlation Test

		Critical thinking skills	Problem-solving skills
Critical thinking skills	Pearson correlation	1	.730**
	Sig. (2-tailed)		.000
	N	144	144
Problem-solving skills	Pearson correlation	.730**	1
	Sig. (2-tailed)	.000	
	N	144	144

According to Triyanti (2022), the PBL model integrated with blended learning can enhance students' critical thinking skills since critical thinking involves cognitive abilities required for logical problem-solving. The data collected corroborates that critical thinking proficiency within the framework of PBL blended learning correlates strongly with problem-solving, as the PBL approach involves group discussions on issues related to environmental change materials (Suwandi et al., 2021).



Figure 5. Student using google sites

Students need to locate pertinent information and grasp it to address environmental issues effectively and apply solutions to real-life situations (Sari et al., 2020). According to Khairati Khairati et al. (2022), employing PBL with environmental change content is essential to bolster and optimize the learning process, fostering reasoning skills in problem analysis. The PBL model has characteristics that show that the problem-centered learning presented refers to authentic problems, information is obtained independently and the teacher is a facilitator (Amalya et al., 2021).

Conclusion

Based on the research conducted, it can be deduced that integrating PBL into blended learning improves critical thinking and problem-solving skills among students at SMAN 1 Kasihan Bantul. The experimental class exhibited a higher average post-test score for critical thinking skills at 85.83 compared to the control class at 75.42. Similarly, the experimental class scored higher in problem-solving skills, with an average post-test score of 85.56 compared to the control class's 71.67.

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Author Contributions

Conceptualization and methodology were done by W.K.; validation was conducted by A.T.P and S.; investigation was carried out by W.K.; writing and editing were performed by W.K.; and review was undertaken by T.A. Each author has examined and endorsed the ultimate rendition of the manuscript.

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Conflicts of Interest

The authors do not have any conflicts of interest to disclose. The funders contributed to designing the study, as well as collecting, analyzing, and interpreting the data, drafting manuscripts, and deciding to publish the findings.

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