Implementation of a Biology Microteaching Model Based on PjBL and Blended Learning

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Abstract: The transformation of education in the era of the Industrial Revolution 4.0 and Society 5.0 requires a paradigm shift in the learning process, including in the education of prospective teachers. Twenty-first-century pedagogical skills such as critical thinking, collaboration, creativity, and digital literacy are essential competencies that future teachers must have. Microteaching as a program to improve teachers' teaching skills needs to adapt to the times. The urgency of this research is to improve the ability of prospective biology teachers to prepare themselves to teach by paying attention to collaboration, communication, creativity, and critical thinking. Therefore, researchers have developed a biology microteaching model based on PjBL (Project-Based Learning) and blended learning to improve the teaching abilities of prospective teachers. The aim of the research is to implement a model to test its effectiveness. This research uses a quantitative approach with a quasi-experimental method. This type of research is in accordance with the quasi-experimental design model, which allows researchers to evaluate the effect of interventions even without subject randomization. The focus of the research is to determine the effect of implementing biology microteaching models based on Project-Based Learning (PjBL) and Blended Learning on the teaching abilities of prospective biology teacher students. This research concludes that the implementation of the microteaching model based on Project-Based Learning (PjBL) and blended learning for Biology students at the FKIP Jambi University received a positive response.

Keywords: Biology; Implementation; Microteaching

Introduction

The transformation of education in the era of the Industrial Revolution 4.0 and Society 5.0 requires a paradigm shift in the learning process, including in the education of prospective teachers. 21st century pedagogical skills such as critical thinking, collaboration, creativity, and digital literacy are essential competencies that future teachers must have (Sadikin et al., 2024b). In the context of biology education, teachers are not only required to understand biological content, but also to be able to package learning that is meaningful, contextual, and technology-based (Sadikin et al., 2024). Microteaching is one of the important stages in a teacher education program, which functions to develop basic teaching skills, such as opening a lesson, explaining the material, asking questions, and closing the lesson (Dursun & Aykan, 2025). However, the implementation of conventional microteaching is often limited to training activities that are simulative, teacher-oriented, and have minimal active involvement of students (Sadikin et al., 2024a). This has an impact on students' low readiness to face real learning challenges in the classroom (Erlina, 2021). Along with the demand for innovative and integrative learning, a training model is needed that is able to hone students' pedagogical skills in a more comprehensive manner. One relevant approach is the integration of Project-Based Learning (PjBL) into microteaching.

PjBL has been proven to be able to improve high-level thinking skills, problem solving, and the ability to work together through involvement in real and meaningful projects (Sadikin, 2024). In teacher education, PjBL plays a role not only in mastering content, but also in practicing context-based and collaborative learning planning (Calderón et al., 2021). Apart from that, developments in digital technology have also encouraged the adoption of Blended Learning as a learning strategy that combines the advantages of face-to-face and online learning (Herliani et al., 2023; O'Flaherty et al., 2023). Blended Learning can increase flexibility, accessibility, and encourage active student participation through the use of Learning Management Systems (LMS) and interactive media (Pohan & Maulina, 2022; Qamarya et al., 2023). In microteaching, the blended approach allows students to design learning that is integrated with technology and practice digital skills as part of modern pedagogical competencies. Several studies show that implementing PjBL and Blended Learning separately has had a positive impact on the quality of biology education students' learning (Ibrahim et al., 2024).

However, the integration of these two approaches in the context of microteaching is still rarely researched, especially in the context of higher education in Indonesia. Therefore, it is necessary to study the implementation of the biology microteaching model based on PjBL and Blended Learning to see to what extent this model can improve the pedagogical skills of prospective biology teachers, as well as to identify obstacles and opportunities in its implementation. This research is relevant and important as an innovative effort in developing a biology teacher education program that is responsive to current needs and capable of producing teachers who are professional, creative, and adaptive to learning technology.

Method

Research Design

This research uses a quantitative approach with a descriptive survey method. The aim is to analyze student perceptions regarding the implementation of microteaching models based on Project-Based Learning (PjBL) and Blended Learning.

Population and Sample

The research population was all students of the Biology Education Study Program, FKIP, Jambi University who took microteaching courses in the even semester of the 2024/2025 academic year. The research sample consisted of 67 students who were determined using a total sampling technique, because all students involved in the microteaching class were included in the research.

Research Instrument

The research instrument is a Likert scale questionnaire (1–4) which was developed based on indicators: Project-Based Learning (PjBL) aspects – contextual and authentic learning experiences; Blended Learning aspects – flexibility, access to materials, and digital literacy; Overall Model Implementation Aspects – integration of PjBL and blended learning in microteaching learning; Support Aspects – infrastructure, the role of the facilitator, and institutional readiness. The instrument was validated through expert judgment to ensure the suitability of the content with the research construct. The reliability of the instrument was tested using Cronbach's Alpha, and the results showed a value of >0.70, so it was considered reliable.

Data Collection Techniques

Data was collected by distributing questionnaires to all respondents online and offline after the PjBL-based microteaching and blended learning lectures were completed.

Data Analysis Techniques

Data were analyzed using descriptive statistics with the help of SPSS software. Analysis was carried out by calculating the minimum, maximum, average (mean), standard deviation, and frequency distribution values for each aspect. Assessment categories are determined based on the average score interpretation criteria: 1.00–1.74 = very low; 1.75–2.49 = low; 2.50–3.24 = high; 3.25–4.00 = very high. The results of the analysis are then interpreted to answer the research focus regarding the effectiveness of student perceptions regarding the implementation of PjBL-based microteaching and blended learning models.

Results and Discussion

Descriptive analysis with SPSS was used to evaluate student perceptions regarding the implementation of Project-Based Learning (PjBL) and blended learning-based microteaching models. The main descriptive statistics are displayed in Table 1.

Table 1. Descriptive Statistics

Variable	N	Min	Max	Mean	SD
PjBL	67	3.0	4.0	3.40	0.33
Blended Learning	67	2.2	4.0	3.14	0.38
Model Implementation	67	2.6	4.0	3.31	0.38
Support	67	2.2	4.0	3.21	0.32

Project-Based Learning (PjBL) Aspects

The results show that the PjBL aspect obtained an average of 3.40 in the very high category. The distribution of respondents' scores can be seen in Table 2.

Table 2. Frequency Distribution of PjBL Aspects

Score	Frequency	Percentage (%)
3.00	16	23.90
3.20	13	19.40
3.40	10	14.90
3.60	16	23.09
3.80	4	6.00
4.00	8	11.90
Total	67	100.00

Aspects of Blended Learning

The blended learning aspect obtained an average of 3.14 in the high category, with a score range of 2.20–4.00, which shows the heterogeneity of student experiences. The score distribution is presented in Table 3.

Table 3. Frequency Distribution of Blended Learning Aspects

Score	Frequency	Percentage (%)
2.20	1	1.50
2.40	1	1.50
2.60	6	9.00
2.80	5	7.50
3.00	22	32.80
3.20	16	23.90
3.40	1	1.50
3.60	8	11.90
3.80	5	7.50
4.00	2	3.00
Total	67	100.00

Overall Model Implementation

The overall implementation of the PjBL-based microteaching model and blended learning obtained an average of 3.31 (very high category). The frequency distribution can be seen in Table 4.

Table 4. Frequency Distribution of Model Implementation

Score	Frequency	Percentage (%)
2.60	1	1.50
2.80	6	9.00
3.00	21	31.30
3.20	7	10.40
3.40	10	14.90
3.40	9	13.40
3.80	6	9.00
4.00	7	10.40
Total	67	100.00

Support Aspect

The support aspect obtained an average of 3.212 in the high category. Several students assessed that infrastructure support and the role of facilitators were still limited, as reflected in the score distribution in Table 5.

Table 5. Frequency Distribution of Support Aspects

Score	Frequency	Percentage (%)
2.20	1	1.50
2.60	3	4.50
2.80	3	4.50
3.00	21	31.30
3.00	12	17.90
3.40	14	20.90
3.60	9	13.40
3.80	3	4.50
4.00	1	1.50
Total	67	100.00

Discussion

The results of this research confirm that the implementation of microteaching models based on Project-Based Learning (PjBL) and blended learning is assessed positively by students. The overall average score of 3.31 (very high category) shows that this model is able to increase meaningful learning experiences, pedagogical skills, and teaching readiness.
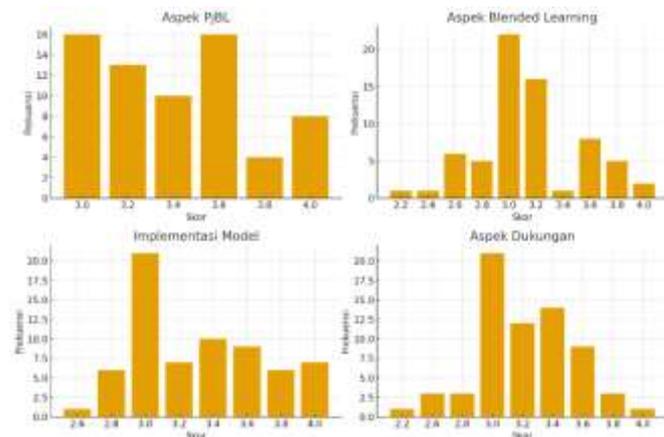

Figure 1. Frequency distribution of aspects of PjBL, blended learning, model implementation, and support

Project-Based Learning (PjBL) Aspects

The average PjBL aspect score (3.409; very high category) confirms that students assess projects in microteaching as providing contextual and authentic learning experiences. In Figure 1, the score distribution is concentrated above 3.4, indicating that the majority of respondents rated it positively. This is consistent with Molina-Torres (2022) and Markula et al. (2022), who report that PjBL increases reflective skills and the ability to design meaningful learning in teacher education. This

finding is in line with research Sadikin et al. (2020) which proves the effectiveness of PjBL-based microteaching in improving critical thinking, communication, collaboration, and creativity skills of prospective biology teacher students. This strengthening is further supported by theoretical frameworks (Lavado-Anguera et al., 2024; Rehman et al., 2024) which emphasizes PjBL as the foundation for developing pedagogical skills based on authentic experience. Globally, the effectiveness of PjBL is also recognized in the literature, where Kokotsaki et al. (2016) and Zhang et al. (2023) emphasize that this model encourages active involvement, improves academic results, and fosters problem solving abilities. Thus, the high achievement in the PjBL aspect shows the strong relevance between the needs of 21st century competencies and the student learning experience at FKIP UNJA.

Aspects of Blended Learning

The blended learning aspect obtained an average of 3.14 (high category) with a score variation of 2.2–4.0. Figure 1 shows a more widely spread-out distribution, indicating heterogeneity in student experiences. These findings are in line with meta-analyses by Schmid et al. (2023) and Shakeel et al. (2023), which emphasize that the effectiveness of blended learning is strongly influenced by infrastructure readiness, digital literacy, and the quality of instructional design. Some students may experience limited access to devices and internet access, so their perceptions are different compared to other colleagues who are more prepared. Even though the blended learning score (3.14) is in the high category, the score is still lower than that of PjBL, which indicates implementation challenges. Students assess that blended learning provides flexibility in accessing materials and opportunities for independent learning, but limitations in digital literacy and technological facilities are obstacles.

This is consistent with the findings of Sadikin et al. (2024c) who highlighted blended learning as an urgent need in the pandemic era, but whose success is determined by infrastructure readiness. International research also shows a similar pattern. Qin (2025) and Tong et al. (2022) found that blended learning is more effective than pure face-to-face learning, but its effectiveness is very dependent on instructional design. This argument is strengthened by Andriani et al. (2023) and Abednego et al. (2023) showing that the perceived effectiveness of blended learning correlates with student learning outcomes, while technical obstacles can reduce the quality of the learning experience. Therefore, the results of this research emphasize the importance of technical and pedagogical support so that blended

learning can be optimized in the context of microteaching.

Overall Model Implementation

The overall implementation of the PjBL-based microteaching model and blended learning obtained an average of 3.31 (very high category). In Figure 1, the distribution of the majority of respondents is in the score 3.00–3.60, which confirms the general positive acceptance. This supports the argument of Subasman (2024) and Yaseen et al. (2025) that project integration with digital technology enriches prospective teachers' learning experiences, improves pedagogical skills, and strengthens learning engagement. This integration allows students to design real projects while gaining the flexibility of digital learning. Fitriati et al. (2024) show that this combination encourages reflective learning, while Kain et al. (2024) emphasize that this model prepares prospective teachers to face the challenges of twenty-first-century learning. International literature also corroborates this. Islam et al. (2022) emphasize blended learning as a transformational strategy in higher education, while Cao (2023) reports that the combination of online and offline models contributes positively to student attitudes and achievement. Hrastinski (2019) further emphasized that blended learning provides a space for richer reflection if integrated with a project-based approach. Thus, the results of this research confirm that the integration of PjBL and blended learning is not only relevant, but also crucial in preparing prospective biology teachers who are adaptive and innovative.

Support Aspect

The support aspect received an average of 3.21 (high category), but the distribution of scores in Figure 1 shows that there is a group of students who rated it low (2.20–2.80). This condition indicates limitations in infrastructure support and the role of facilitators. Graham (2013), emphasized that the success of learning innovation is very dependent on institutional support in the form of policies, digital infrastructure, and lecturer assistance. Luo et al. (2024) emphasized that students' perceptions of microteaching are greatly influenced by the availability of facilities and the readiness of lecturers as facilitators. Research by Tondeur et al. (2012) and Topping et al. (2022) also shows that lecturers' digital competence and institutional support are key factors that determine the success of technology integration in learning. Trust et al. (2018) added that institutional support, both in the form of infrastructure and policy, influences the extent to which blended learning can run effectively. Therefore, even though the support has been assessed as good, the results of this research indicate the

need to strengthen aspects of infrastructure and to develop the digital competence of lecturers so that the implementation of the microteaching model is more optimal.

Implications

The combination of quantitative data (tables), frequency distributions (graphs), and discussion of the literature confirms that PjBL and blended learning complement each other: PjBL provides an authentic context, while blended learning expands access and flexibility. However, disparities in technological support and readiness require additional intervention in the form of digital literacy training, provision of devices and networks, and strengthening the role of facilitators. With this strategy, the implementation of PjBL-based microteaching and blended learning can more consistently improve the pedagogical competence of prospective teachers in various contexts. The findings of this research have important implications, both locally and globally. Locally, the research results confirm that PjBL-based microteaching and blended learning can improve the quality of the learning experience of prospective biology teacher students at FKIP UNJA. However, there are challenges in the form of variations in student readiness and infrastructure limitations that need to be addressed through institutional policies and digital literacy training.

Globally, these findings are consistent with the meta-analyses of Bernard et al. (2014) and Guo et al. (2020) which reported that the combination of projects and technology resulted in significant improvements in academic outcomes and 21st century skills. Thus, this research not only provides an empirical contribution to the local context but also enriches the international literature regarding the implementation of PjBL and blended learning in microteaching. The practical implication is the need for robust instructional design, institutional support, and further research with a quasi-experimental approach to more comprehensively test the impact of this model on students' cognitive, affective, and psychomotor domains.

Conclusion

This research concludes that the implementation of the microteaching model based on Project-Based Learning (PjBL) and blended learning for Biology students at FKIP Jambi University received a positive response. The PjBL and overall implementation aspects are rated very high, while the blended learning and support aspects are rated high. These results confirm that the combination of PjBL and blended learning is effective in strengthening pedagogical skills,

collaboration, digital literacy, and the teaching readiness of prospective biology teachers. However, there are still challenges in the form of limited infrastructure support, lecturer readiness, and variations in student digital literacy. Therefore, this research recommends the need to improve learning facilities, to train lecturers in PjBL-based instructional design and blended learning, as well as to implement programs to strengthen digital literacy for students. It is recommended that further research use a quasi-experimental design to test the effectiveness of this model on cognitive, affective, and psychomotor outcomes more comprehensively.

Author Contributions
Conceptualization, A.S, J.S. Developing Product; A.S, J.S. Analyzing Data, M.Y, D.A.E.P.S.; Drafting Article, A.S, M.Y, D.A.E.P.S.

Conflicts of Interest
The authors declare no conflict of interest.

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