



Improving teaching quality: Development of the PjBL microteaching model for prospective biology teachers

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ARTICLE INFO

Article history

Received: 27 May 2024

Revised: 10 September 2024

Accepted: 30 September 2024

Keywords:

4 C skills

Blended learning

Microteaching model

PjBL

ABSTRACT

Educational institutions prepare prospective biology teachers so they can carry out learning effectively and efficiently. However, there is a gap in meeting the needs for effective learning for prospective biology teachers. Based on a survey of 177 prospective teacher students, it was found that they preferred microteaching to be integrated with the project-based learning model. The aim of this research is to develop a PjBL-based microteaching model. The research method employed is Research and Development (R&D) using the ADDIE model. The research subjects were 36 fourth-semester students from the Biology Education Study Program who were enrolled in microteaching courses. The PjBL-based microteaching model has the syntax, (1) Instructional to the concept of microteaching, (2) plan, (3) teach, (4) feedback and reflection, (5) project collection, (6) project evaluation. Conclusion: This PjBL-based microteaching model is developed from microteaching and PjBL theories. The PjBL-based microteaching model for prospective biology teachers is deemed suitable for use, as indicated by validator assessments and small group and large group tests. Based on the results of the large group trials, it is evident that this model positively impacts the 4C skills of prospective biology teachers.

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INTRODUCTION

Biology teacher competencies include pedagogical, professional, personal and social competencies. Pedagogical competence is the biology teacher's ability to plan and implement biology learning to achieve learning objectives (Dervenis et al., 2022). The development of pedagogical competence for teachers continues to be an interesting issue to be researched from various subjects and levels of education (Cebrián et al., 2020). The development of pedagogical competencies for prospective teachers needs to be integrated into the curriculum of educational institutions (Cebrián & Junyent, 2015). Innovation in learning methods needs to be provided to prospective biology teachers (Barbara et al., 2004; Cochran-smith & Villegas, 2015). Efforts to improve the knowledge and skills of prospective teachers are a step forward in teacher education programs (Knight et al., 2014).

Microteaching as a learning model that can train prospective teachers' pedagogical competencies is not yet future-oriented. Microteaching is a training method for prospective teachers to practice teaching skills with students, material and limited time to increase the self-confidence of prospective teachers (Siburian & Sadikin, 2022). Based on a survey of 177 respondents from biology education study program students who wanted microteaching learning by implementing the Project-based learning (PjBL) model. Constructive and project-oriented learning experiences increase students' active participation, motivate them to learn, and assist in mastering various skills (Gómez-Pablos et al., 2017). According to Çelik et al., (2018), PjBL involves a learning cycle of planning, implementation and reflection stages. Projects given to students must be complex and require problem-solving based on critical thinking. Apart from that, PjBL also encourages students to conduct independent research, gather information, and collaborate with teammates. The syntax of the PjBL learning model includes: (1) determining basic questions, (2) preparing project plans, (3) preparing schedules, monitoring projects, (4) assessing results and (5) evaluating experiences (Mergendoller & Thomas, 2005).

However, until now no one has integrated microteaching with the PjBL model. For this reason, developing a PjBL-based microteaching model is necessary so that learning can be project-oriented. So that it can improve critical, creative, communicative and collaborative thinking skills among prospective teacher students in developing planning and implementing learning. With PjBL, effective teaching skills will be trained in preparing prospective teachers to become active and responsive educators in accordance with the learning needs of the 21st century (Azrai et al., 2020). Collaboration and communication skills can encourage prospective biology teacher students to be able to work together and convey their thoughts smoothly and systematically (Greenstein, 2012). Therefore, it is necessary to develop a PjBL-based microteaching model for prospective biology teachers.

METHODS

Research Design

This research is a development study that uses the ADDIE model. The ADDIE model consists of This type of research using research & development with the ADDIE Model (analysis, Design, Development, Implementation and Evaluation). The analysis stage is carried out to see the need for the product to be developed. In the design stage.

Analysis Stage

The analysis stage of this research involves several steps, including general objective analysis, learning analysis, and analysis of learners and learning environments.

Design Stage

In the design stage, the following activities were carried out: (1) formulating learning objectives based on the previous analysis. Based on the review of the earlier analysis, the learning objectives for the PjBL-based microteaching model were designed to train 4C skills using the PjBL framework. (2) Developing assessment instruments, which consist of questionnaires, validation sheets, observation sheets, and documentation. The questionnaire instrument was used to gather data on the type of learning preferred by prospective biology teachers. The validation sheet was used to collect feedback and comments from validators regarding the developed product. The observation sheet was used to gather data on the 4C skills of prospective biology teachers. The indicators for measuring 4C skills were adapted from Laura M. Greenstein (2012). These indicators were also integrated into every stage of the PjBL-based microteaching model. (3) Developing the PjBL-based microteaching model, which includes

the stages: The syntax includes: (1) Orientation towards the project, (2) Preparation of teaching modules, (3) Peer review, (4) Presentation of peer review results, (5) Teaching practice and peer review, (6) Presentation of teaching practice results, (7) Collection of learning video projects and (8) Project assessment.

Development Stage

The development of the microteaching model was carried out by detailing each stage according to the design and applying it to a Learning Management System (LMS). A guidebook and project logbook were also developed as tools for students to carry out the project. The logbook was designed based on the initial design and includes 4C skills indicators. At this stage, product validation by subject matter experts and media experts was conducted to gather feedback for product improvement. One-on-one testing was conducted to ensure ease of use, followed by small group testing to assess the clarity of materials, the impact of the product, and its feasibility.

Implementation Stage

After careful one-on-one testing and small group trials, the research progressed to a more comprehensive field trial for product implementation. This stage is crucial for validating the effectiveness and practicality of the PjBL-integrated microteaching model aimed at developing 4C skills in prospective biology teachers within a real-world classroom setting. A pre-experimental design with pre-test and post-test was used, involving only one class (class R002), to gain insights into the impact of the PjBL-integrated microteaching model on the 4C skills of students enrolled in this course.

Evaluation Stage

The evaluation of the PjBL-based microteaching model aimed at training 4C skills (Collaboration, Communication, Creativity, and Critical Thinking) in prospective biology teachers has demonstrated significant progress and dynamics.

Research subject

In this study, the subjects taken were biology education students taking microteaching courses. Even semester students in the 2023-2024 academic year. The subjects were 36 students.

Research instrument

This research uses questionnaire instruments, validation sheets, observation sheets and documentation. Questionnaires are used to collect data on students' desired learning needs. Validation sheet to assess the feasibility of the product being developed in the form of a PjBL-based microteaching model. Observation sheets are used to see the implementation of microteaching learning and documentation is used to see research evidence. The data collection instruments consist of a questionnaire, validation sheet, observation sheet, and test. The questionnaire instrument is used to gather data on the preferred type of learning by prospective biology teachers. The validation sheet is utilized to collect feedback and comments from validators regarding the developed product. The observation sheet is employed to collect data on 4C skills and teaching skills of prospective biology teachers.

Data analysis technique

Data analysis uses research instrument triangulation. To see the feasibility of the product and the implementation of PjBL-based microteaching learning for prospective biology teachers. The data analysis technique employed a t-test to examine the differences in 4C skills before and after being taught using the PjBL-integrated microteaching model, utilizing the one-group pre-test and post-test design. The results from the one-on-one trials and small group trials were analyzed by calculating the score for each question item and subsequently determining the percentage for each item.

RESULTS AND DISCUSSION

Analysis Stage

At this stage, research questionnaires were distributed and filled out by 177 biology education students. The data obtained was that 87.32% of biology students wanted microteaching to be carried

out using the PjBL model, 9.86% of biology students said they were neutral and 2.82% said they disagreed.

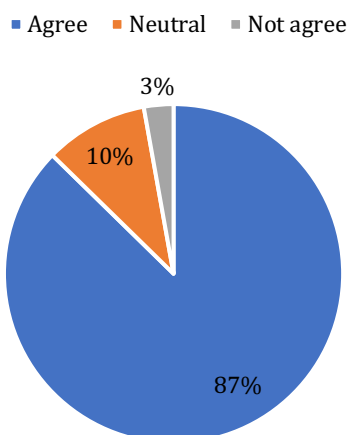


Figure 1. Results of the Needs Analysis Survey About Developing Product

Based on the results of the survey and analysis that has been carried out, there is an urgent need to develop a PjBL-based microteaching model. From various references, it was found that there are 11 microteaching models in the world. First, the lesson study-based microteaching model includes the stages of planning, teaching, reflecting, and revising lesson plans (Fernández, 2005). Second, the Learner-centered Micro Teaching (LCMT) Model is a student-centered microteaching model (Kilic., 2010). Third, the internet and multimedia-based microteaching model involves the use of the internet and multimedia as facilities and infrastructure (Yuan et al., 2013). Fourth, the microteaching model in medical faculties is designed specifically for prospective medical teachers (Remesh, 2013). Fifth, the Extended Technique-based microteaching model includes a cycle of teaching, criticizing, re-planning, re-teaching, and re-criticizing (Peker, 2009).

Sixth, the traditional microteaching model has stages: planning, teaching, observing, re-planning, re-teaching, re-observing, and returning to planning (Onwuagboke et al., 2017). Seventh, the Real Time Coaching (RTC) Microteaching model includes the stages of preparation, teaching, feedback, and actual classroom teaching for prospective teachers (Stahl et al., 2018). Eighth, Microteaching Lesson Study (MLS) can improve prospective teachers' teaching skills and collaborative abilities, including planning, teaching, reflection and revision (Zhou & Xu, 2017). Ninth, the doll-based microteaching model from Japan includes students' understanding in groups, group instruction, one-to-one interaction regarding students' understanding, class content, and discipline (Wakimoto et al., 2019). Tenth, the studio-based microteaching model includes planning, implementation, change decisions, and evaluation (Yun, 2022). The steps in designing microteaching vary among experts. This is the result of our analysis from various literatures.

Table 1.
Analysis of Microteaching Models from Various Literature Sources

Components	MT	MLS	LCMT	MBIM	MIK	MTE	MRT	RTC	MBW	MBS	MI	MPB
Concept	√	-	-	√	√	-	-	-	-	√	√	√
Plan	√	√	√	√	√	√	√	√	√	√	√	√
Teach	√	√	√	√	√	√	√	√	√	√	√	√
Observation	√	-	√	√	√	√	√	-	√	√	√	√
Reflection	√	√	√	√	√	√	√	√	√	√	√	√
Re-teach	√	-	√	√	√	√	√	√	√	√	√	√
Revision	-	-	-	√	-	-	-	-	-	-	-	√
Videotaping	-	-	√	√	-	-	-	-	-	-	-	√
Evaluation	-	-	-	√	-	-	-	-	-	-	√	√
Synchronous	-	-	-	√	-	-	-	-	-	-	-	√
Asynchronous	-	-	-	-	-	-	-	-	-	-	-	√
Review	-	-	-	-	-	-	-	-	-	-	-	√

Components	MT	MLS	LCMT	MBIM	MIK	MTE	MRT	RTC	MBW	MBS	MI	MPB
(Students)												
Review	-	-	-	-	-	-	-	-	-	-	-	√
(Teacher)												
Project	-	-	-	-	-	-	-	-	-	-	-	√
Media	-	-	-	√	-	-	-	-	√	-	-	√
Teaching	√	√	√	√	√	√	√	√	√	√	√	√
Skills												
4C Skills	-	-	-	-	-	-	-	-	-	-	-	√

Legend:

- MT: Traditional Microteaching
- MLS: Microteaching Lesson Study
- LCMT: Learner-Centered Microteaching
- MBIM: Internet and Media-Based Microteaching
- MIK: Medical Knowledge-Based Microteaching
- MTE: Extended Technique Microteaching
- MRT: Re-teach Microteaching
- RTC: Real-Time Centered Microteaching
- MBW: Puppet-Based Microteaching
- MBS: Studio-Based Microteaching
- MI: Indonesian Microteaching
- MPB: PjBL-Based Microteaching

Design Stage

At the design stage, the development of a PjBL-based microteaching model was carried out by constructing microteaching and PjBL theories. The results of this theoretical construction create a new and innovative microteaching model syntax. The syntax includes: (1) Orientation towards the project, (2) Preparation of teaching modules, (3) Peer review, (4) Presentation of peer review results, (5) Teaching practice and peer review, (6) Presentation of teaching practice results, (7) Collection of learning video projects and (8) Project assessment. The theoretical construct of the syntax formation process of the PjBL-based microteaching model is as shown in Figure 2.

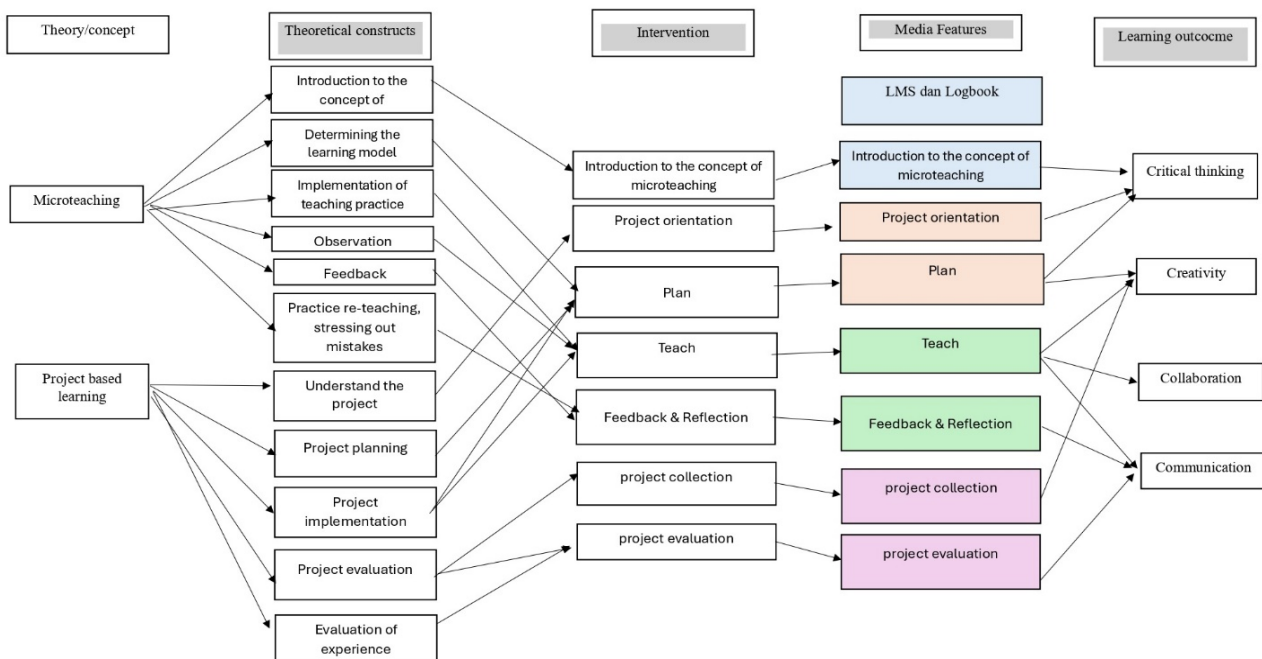


Figure 2. Theoretical Construct of the PjBL-based microteaching model

Development Stage

At this stage, the researcher applies the model syntax to the logbook and Learning Management System (LMS). The aim is to ensure that the syntax can be translated into student activities during microteaching learning. The features of the LMS can be seen in [Figure 3](#).

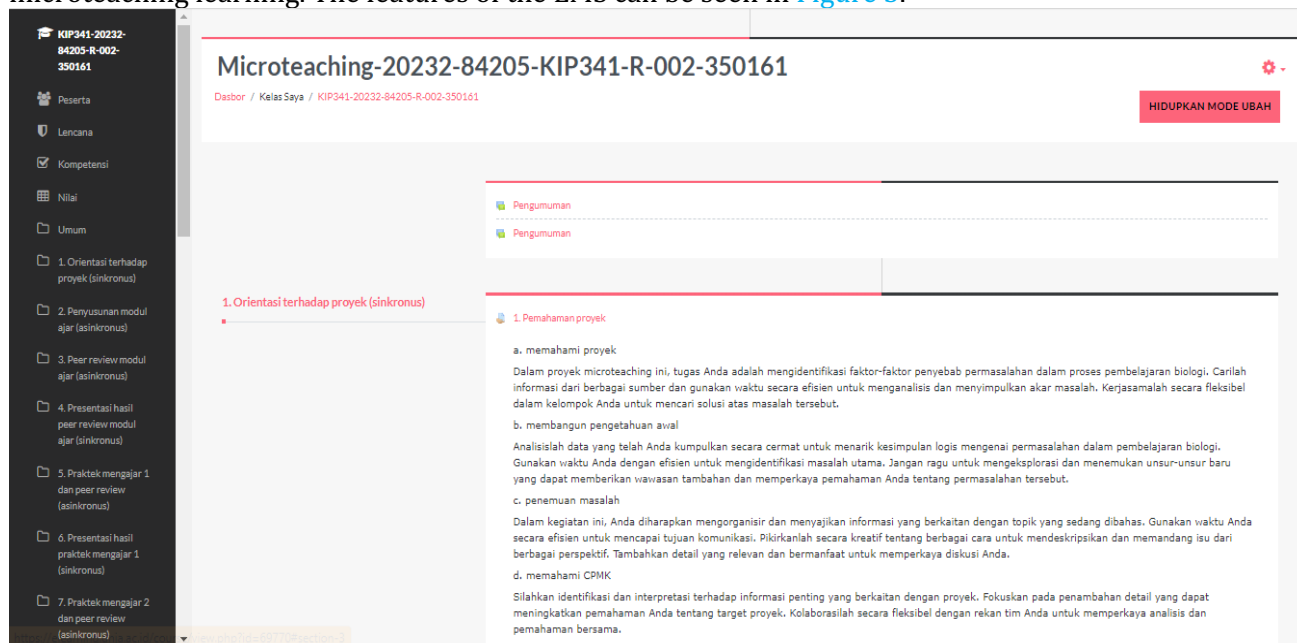


Figure 3. Learning Management System

Apart from creating an LMS, a logbook was also developed as a worksheet for students in carrying out projects. The purpose is to provide guidance to students in planning, implementing and evaluating projects. After the syntax, logbook and LMS have been developed, the next stage is the validation stage. Validation includes conceptual validation, media and biological material. Conceptual validation was carried out twice. The first validation obtained input to clarify student activities carried out for each syntax, add assessment instruments for student activities and use the sentences in the descriptor to be used as command sentences in training the 4 C indicators in the logbook and in the LMS. In this first validation, it obtained a score of 73 (decent category). The second validation received input and suggestions that each stage of the logbook and LMS must be in accordance with the independent and dependent variable linkage table. In this second validation, it received a score of 85 (very feasible category).

In media validation, it is carried out twice, getting input from the validator, including: the logbook writer should only be a researcher who does not need to enter the supervisor's name, the cover should provide an overview of microteaching, and the logbook title should be changed to microteaching project logbook. In media validation, it got a score of 92 (very feasible category). Meanwhile, validation of biological material was carried out twice, with the suggestion that the biological material package prepared should be appropriate to the level of the educational unit, should be equipped with pictures and examples to clarify the material. In the validation of biological material, it received a score of 87 (very feasible category).

Implementation stage

At the implementation stage, small group tests and large group tests were carried out. In the small group test, the product was tested on 6 biology students. to get input and suggestions on whether the logbook and LMS created are easy to use and the language used does not cause misunderstandings. The results obtained were that the readability of the media was good and suitable for use, but the LMS should add references and examples of microteaching videos. In the small group trial, a score of 88 was obtained (very feasible category).

In a large group trial, the product was tested on 34 biology students for one semester. The results obtained were that the learning planning which was originally one meeting on the syntax of project orientation, plan and evaluation became two meetings because it required a lot of time, constraints on setting schedules and microteaching laboratory infrastructure. Then, in the syntax of feedback and

reflection, which consists of two meetings, it turns out that once in class, face-to-face is enough. The results of large group trials can be seen in [Table 1](#).

Table 1.

Scenario of PjBL microteaching model learning

Initial Design (Planning)		Final Design (After repairs according to conditions in the field)		Information
Meeting	Learning Activity	Meeting	activity	
1	College contract	1	College contract	
2	project orientation	2 & 3	project orientation	Requires strengthening of teaching skills material
3	Preparation of teaching module 1 ATP (plan)	4 & 5	Preparation of teaching module 1 ATP (plan)	Preparing Teaching Modules requires more time
4	Peer review	6	Peer review	
5-6	Presentation of Peer Review Module Results	7	Presentation of Peer Review Module Results	
7-8	Simulation I in Groups and Peer review (teach)	8 & 9	Simulation I in Groups and Peer review (teach)	Time adjustments for student preparation and booking room availability for simulations
9-10	Presentation of simulation results 1	10	Presentation of simulation results 1	
11-12	Simulation 2 in Groups and Peer review (teach)	11 & 12	Simulation 2 in Groups and Peer review (teach)	Time adjustments for student preparation and booking room availability for simulations
13-14	Presentation of simulation results II	13	Presentation of simulation results II	
15	Project collection	14	Project collection	
16	Project evaluation	15 & 16	Project evaluation	Fulfillment of Product Assessment and Course Evaluation Criteria

From the application of the PjBL-based microteaching model for prospective biology teachers in the classroom, the results were that the LMS and logbook were suitable for use and could improve students' 4C abilities before and after treatment. Where the average 4C pretest only got a score of 2.6 (fair) which increased to a score of 3.1 (good category).

At the needs analysis stage, data was obtained that respondents wanted microteaching learning using the PjBL model. Implementation of the PjBL Model can improve students' critical, creative and collaboration thinking skills (Palaninatha Raja & Abirami, 2022). In developed countries, PjBL is being adopted in learning because it can prepare students for increasingly complex challenges (Hallsworth, 2023). However, it is important to note that the success of PjBL is highly dependent on project design, support from educators, and available resources (Kamdi, 2020).

At the design stage, theoretical constructs from microteaching and PjBL were implemented which gave rise to a syntax for introducing microteaching concepts, project orientation, plan, teach, feedback, reflection and evaluation. The process of introducing concepts and project orientation is the foundation of knowledge for students who will carry out learning. This is in accordance with assimilation theory that knowledge and experience will make it easier for students to learn further (E & Gredler, 2011; Xie & Greenman, 2011). Every student has the ability to receive knowledge (van der Veer, 2020). Therefore, students must be actively involved in the learning process (E & Gredler, 2011; Sikandar, 2016). Through the orientation process for this project, students will be trained to apply critical thinking and communication skills.

Meanwhile, at the plan stage, students use their initial knowledge to prepare learning plans or projects. This teaches them to carry out observations, literacy, and interviews with sources. This is in line with the learning theory put forward by Dewey (E & Gredler, 2011; Sikandar, 2016).

In the practice or teach stage, each student practices teaching in class based on the plan that has been prepared. In this activity students will use all their abilities to open the lesson, explain the material, provide examples and display media, manage the class, and close the lesson. Prospective teacher students will be trained in creative and communication skills in this activity. The ability to communicate well is also key in this global era. According to Trilling & Fadel, (2009), effective communication involves the ability to listen attentively, articulate ideas clearly, and use various communication media. This prepares students to communicate with a variety of audiences. Creativity is becoming an increasingly important skill in facing the complex challenges of the 21st century. According to Urbani et al., (2017) creativity involves the ability to generate new and original ideas, as well as solve problems with innovative approaches. Creativity is also related to flexibility of thinking and seeing problems from different points of view.

The next syntax is feedback and reflection. At this stage, students provide feedback to each other on the work of other group members, interact intensively and correct what is still wrong with the project being created. The learning theories that support this activity are constructivism theory (Trianto & Pd, 2007) and humanism (Ariwidodo, 2022). Evaluation of the project implementation process is carried out to obtain input in the form of constructive suggestions to form the basis for future process improvements. The skills acquired are communication and collaboration skills. The theory supporting this activity is Kolb's learning experience theory (Fauziah & Kamal, 2024).

CONCLUSION

It can be concluded that this PjBL-based microteaching model is constructed from microteaching theory and the principles of PjBL. The PjBL-based microteaching model for prospective biology teachers is deemed suitable for use based on validator assessments, as well as small-group and large-group tests. The results from the large group trials indicate that this model positively impacts the 4C skills of prospective biology teachers.

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