Microteaching to Develop Prospective Biology Teachers' Basic Teaching Skills Following Next Generation Science Standards (NGSS)

Parmin Parmin[1]*, Lilia Ellany Mohtar[2], Ahmad Muhlisin[3], Eli Trisnowati[3], Ika Sukmawati[4]

[1]Integrated Science Education, Universitas Negeri Semarang, Indonesia
[2]Faculty of Science and Mathematics, Sultan Idris Education University, Malaysia
[3]Integrated Science Education, Universitas Tidar, Indonesia
[4]Biology Education, Universitas Tidar, Indonesia

*Corresponding Author: parmin@mail.unnes.ac.id

Abstract. Prospective biology teachers have good mastery of the material but are still weak in several indicators of basic teaching skills. Preparing prospective professional biology teachers in Indonesia expects graduates to be able to teach not only in domestic schools but also in schools abroad by integrating Next Generation Science Standards. This study aims to develop prospective teachers' basic teaching skills that integrate Indonesian standards and the Next Generation Science Standards (NGSS) through best practices of microteaching innovation. The research used the Research and Development method. Microteaching lecture tools for prospective biology teachers were developed. The research targets were 82 prospective biology teachers in microteaching courses who were given the same learning environment. The six biology teachers involved came from three partner schools with different statuses: public, nationalist private, and religious private. A t-statistic model comparison test strengthens this finding, where the score of the second microteaching practice differs from the first practice. This research is a form of curriculum implementation for prospective science teachers who integrate NGSS. This research finds that the practice scores in the second microteaching increase after analyzing the first teaching practice video. The impact of these findings provides solutions to create skillful prospective biology teachers.

Keywords: microteaching; generation science; prospective science teachers

INTRODUCTION

The challenges of preparing prospective biology teachers are currently more complex due to the characteristics of the millennial generation studying as prospective teachers. The millennial generation is mentally unstable, impatient, and wants to achieve things quickly (Bhattacharya & Gandhi, 2020; Brailovskaia & Bierhoff, 2020; Hamm et al., 2020). The millennial generation's weakness in learning is that they are impatient in doing things in stages and are easily influenced by digital content on social media. The millennial generation, who are prepared to become teachers, faces the difficult challenge of learning and practicing various characteristics that are contrary to their nature. The problem is also compounded by the phenomenon that not all students studying as prospective biology teachers are interested. They have various reasons for learning in an education program, such as dreams, encouragement from parents, developments in workforce needs, or simply trying their luck (Gozali, 2019; Taufiq et al., 2024). Education program institutions are facing various serious challenges. Moreover, research on developing basic teaching skills in Indonesia has decreased in number and quality.

Prospective biology teachers who practice teaching at partner schools have good mastery and comprehension of the material. They have a good mastery of biology content. Aspects of knowledge were assessed through direct learning observations using material mastery instruments. Prospective biology teachers have good mastery of the material but are still weak in several indicators of basic teaching skills. The knowledge of prospective biology teachers needs to be

supported by pedagogical skills (Susantini et al., 2019; Suryawati et al., 2017; Subowo et al., 2023). According to the observations of supervising lecturers and teachers during teaching internships, determining students' initial knowledge, classroom management, and variations in teaching strategies are the weak teaching skill indicators. Prospective teachers have teaching skills from excellent microteaching (Sezen et al., 2014; Pekdağ et al., 2021; Murphy, 2022).

Curiosity in students also makes it easier for prospective teachers to achieve learning goals. Students are interested in learning material if it is related to their initial knowledge (Younis et al., 2021; Yang et al., 2021; Yeo et al., 2022). Classroom management is created through the skills of prospective teachers in implementing adaptive learning (Vedder, 2018; Schweder, 2020). The skills to determine prior knowledge and manage the class require the skill to vary teaching strategies. Variations in teaching strategies are needed because the characteristics of students vary while the learning objectives are the same (Nouri, 2019; Andrews, 2022; Fibonacci et al., 2024). Preparing prospective professional biology teachers in Indonesia expects graduates to be able to teach not only in domestic schools but also in schools abroad. Next Generation Science Standards (NGSS) is an integrated international education standard to create a generation that makes science a daily lifestyle (Duschl & Bybee, 2014; Ndumanya et al., 2021). The preparation of prospective biology teachers who meet the NGSS includes the skills to determine clear goals for all students, prepare accurate scientific learning, limit specific material, deliver material from research, and fulfill students' various learning needs (Drew, 2018; Christian et al., 2021).

A future generation that is biologically literate is very strategic to be created by preparing prospective teachers who understand the NGSS criteria (Krajcik et al., 2014; Granucci et al., 2017). NGSS criteria are assessed through educational lectures, microteaching, and teaching practices in partner schools. Prospective teachers are trained to develop learning tools, starting from syllabi, lesson plans, teaching materials, and assessments that integrate NGSS criteria. The profile of future biology teachers is required to have deep and comprehensive content mastery, teaching skills with information technology, multidisciplinary integration of biology, a scientific spirit, and human literacy by applying concepts to meet life's needs (Parmin & Khusniati, 2021; Juanda et al., 2021; Suhirman et al., 2022).

NGSS is an international standard for the next generation of science that can be realized through the study of biology.

Standards for biology teachers in Indonesia in Minister of Education Regulation Number 16 of 2007 need to be elaborated with Next Generation Science Standards (NGSS). According to the new standards referred to by the NGSS, education to prepare prospective biology teachers continues and produces thousands of graduates. Biology is part of science, and the essence of science, according to the NGSS, includes eight aspects: (1) Investigation using varied methods, (2) Knowledge based on empirical evidence, (3) Knowledge is open to revision, (4) Models, laws, mechanisms, and theory explain phenomena, (5) A way to understand, (6) Knowledge assumes an orderly and consistent system, (7) Human endeavor, and (8) Asks questions about nature and the world consistently (Bybee, 2014; Weinstein, 2017). Collaboration between educators can be developed through sharing experiences about various good practices carried out by each other in learning (Nielsen & Jensen, 2021; Nguyen & Dang, 2021). The success of microteaching lectures is determined by the basic teaching skills of prospective teachers from opening to closing the lesson (Hong et al., 2017). Best practices in learning innovation in schools are owned by teachers who strongly desire to teach professionally (Du, 2020; Kaasila et al., 2021).

This research focuses more on preparing prospective biology teachers through microteaching courses. The focus of the research was determined by considering the sporadic involvement of supervising teachers in implementing microteaching. Experience in the form of various teachers' best practices has not been utilized to form skillful prospective teachers. Involving teachers from partner schools as mere tutors during internships is not enough because their function is limited to mentoring. This study aims to develop prospective teachers' basic teaching skills that integrate Indonesian standards and the Next Generation Science Standards (NGSS) through best practices of microteaching innovation. The research results are expected to make a real contribution as recommendations for innovation in preparing prospective professional biology teachers. Research products play a role in realizing quality education according to the Sustainable Development Goals (SDGs) targets in Indonesia by improving prospective teachers' teaching skills. This research is a form of curriculum implementation for prospective

science teachers who integrate NGSS.

METHODS

Research Design

The research used the Research and Development method (Borg & Gall., 1989). Microteaching lecture tools for prospective biology teachers were developed, referring to Dick and Carey (2001). The research involved six main stages: preliminary study, initial draft design, initial draft validation and revision, small-scale trial for the first revision, large-scale trial for the second revision, and the final product. The research developed a product in the form of a model video of teaching skills with high applicability. The resulting model video was applied in microteaching to prepare prospective biology teachers in Indonesia. The video developed has advantages that other videos do not have, in the form of basic teaching skills according to the standards in the Minister of Education Regulation Number 16 of 2007 and NGSS. An advantage that is still very rare lies in the involvement of teachers from partner schools in microteaching. The teachers act as active observers and resource people to discuss and provide feedback from the observations. Each prospective teacher analyzes previous teaching practice videos before teaching practice. The microteaching lecture tools in this research were developed by identifying lecture objectives, analyzing the lecture process, developing lecture implementation strategies, developing lecture materials, and conducting evaluations and reflections at the end of the lecture.

The treatment design in this study is presented in Figure 1.

Participants

The research targets were 82 prospective biology teachers in microteaching courses who were given the same learning environment. The six biology teachers involved came from three partner schools with different statuses: public, nationalist private, and religious private. The research target has completed introductory science and pedagogy courses. Targets were conditioned to wear a microteaching lecture uniform: a white shirt and black trousers or skirt plus a tie for prospective male teachers. Each prospective biology teacher carried out teaching practice twice as a teacher and as a student in other meetings acts. The innovation developed in this research is that every prospective teacher who practices teaching is given the opportunity to first listen to and analyze the microteaching videos from the previous meeting. The analysis aims to enable prospective teachers to learn the strengths and weaknesses of previous practices and improve them. This pattern continues repeatedly. These tiered videos will produce teaching skills development products. At the end of this research, the best video on microteaching prospective biology teachers was created.

Data Collection

The data collected included validation and effectiveness testing of the microteaching video products developed. The products developed in this research were limited to microteaching videos as treatment material in the preparation of prospective biology teachers. The video product has innovation where microteaching involves teachers from partner schools. The second innovation is where the product is oriented towards the teaching skills standards of the NGSS. The effectiveness of the product was tested in microteaching lectures at the Department of Biology Education of Universitas Tidar. The effectiveness test data collected is the teaching skills of prospective biology teachers, from opening to closing the lesson. The microteaching instruments used are novel because they were developed specifically by elaborating on the Indonesian standards and the Next Generation Science Standards. Microteaching measurement instruments that elaborate the NGSS are still difficult to find in Indonesia. The instruments used consisted of product validation sheets, microteaching observation sheets, and teaching skills observation sheets as a result of treatment. Video product validation involved learning media experts, microteaching experts, and biology experts.
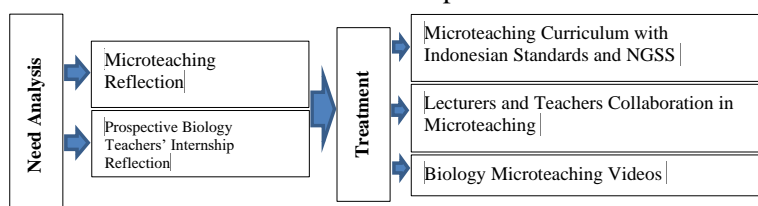

Figure 1. Research Treatment Design

Data Analysis

Product validation data was processed from the content of validation sheets with a Likert scale. The level of product validity was calculated from the percentage by validators (the results are rounded up to a whole number) and the total score for each selected criterion. The first video assessment was developed on a scale of 4.3-5 (very good), 3.5-4.2 (good), 2.7-3.4 (average), 1.9-2.6 (poor), and 1-1.8 (very poor). Achievement level qualifications used three percentage ranges: very feasible (86-100), feasible (70-85), and not feasible (< 70). Data were analyzed descriptively by referring to the calculation results of each assessment item. Validation criteria are very feasible (3.25-4), feasible (2.51-3.25), and not feasible (< 2.50).

RESULTS AND DISCUSSION

The research began by analyzing the characteristics of the basic teaching skills of prospective biology teachers according to Indonesian standards and Next Generation Science Standards. The integration of Indonesian teacher standards with NGSS was carried out through the Focus Group Discussion (FGD) with biology experts, biology education experts, and education experts. The integration results were developed in the form of adding new criteria in four teacher competencies in Indonesia. The results of the integration of Indonesian teacher standards with NGSS are presented in Table 1.

Skills in managing learning with varied approaches, models, and methods are criteria for pedagogical competence. The variations in learning strategies in this research were assessed through learning tools prepared by practitioners.

Practitioners used various approaches, models, and methods in teaching modules. The approach to biological learning is determined by analyzing the characteristics of the material and the available learning support (Dutta & Ghosh, 2024; Byukusenge et al., 2024). Analysis of the learning stages prepared by practitioners leads to understanding the biology concepts being taught. Learning activities use student worksheets and observation worksheets so that the concepts taught are understood through empirical evidence. Biology is taught through direct observation of learning objects to build empirical concepts (Vaidyanathan et al., 2023; Shamdas, 2023).

From the observers' notes in microteaching, when there were questions from students to practitioners, arguments occurred between students in class, and the teacher used explanatory sentences that showed an open-minded attitude towards biology knowledge. The practitioner's open-minded attitude is demonstrated by the action of facilitating students to explore learning resources to discover concepts. An open-minded attitude about knowledge triggers a search for truth using various literature (Pearce et al., 2024). The integration of Indonesian teacher standards with NGSS can be practiced during microteaching. Practitioners can implement new criteria developed in research because the assessment criteria in microteaching have been explained before teaching practice.

The research began by producing microteaching videos as material for the first stage of analysis before practitioners started teaching practice. Before use, microteaching videos are assessed for feasibility by experts. The assessments of learning media experts, biology experts, and biology education experts on the first video developed are presented in Table 2.

Table 1. Integration of Indonesian Teacher Standards with Next Generation Science Standards

Teacher Competencies in Minister of Education Regulation Number 16 of 2007	Next Generation Science Standards	Integration of Indonesian Teacher Standards with NGSS
1. Pedagogy 2. Personality 3. Social 4. Professional	1. Investigations use varied methods. 2. Knowledge is obtained from empirical evidence. 3. Knowledge is open to revision, 4. Models, laws, mechanisms, and theories explain phenomena. 5. There is a way to understand. 6. Knowledge assumes an orderly and consistent system. 7. Knowledge can stimulate human efforts to fulfill needs. 8. Effort to always ask questions about nature.	1. Manage learning with varied approaches, models, and methods (pedagogy). 2. Learning activities are developed to understand knowledge (pedagogy). 3. Develop an open attitude towards knowledge (social). 4. Knowledge is obtained from empirical evidence (professional). 5. Models, laws, mechanisms, and theories explain natural phenomena to fulfill needs (professional).

Table 2. Expert Assessment of Microteaching Videos

| Expert	Assessment	Score (Category)
Biology	Concept truth	4.6 (very good)
	Suitability to learning objectives	4.8 (very good)
	Explanation of contextual material	4.0 (good)
Biology Education	Opening lesson	3.8 (good)
	Conveying adjectives	4.2 (good)
	Guiding the discussion	3.6 (good)
	Explaining the material	4.0 (good)
	Managing classroom	3.6 (good)
	Giving rewards	3.4 (poor)
	Closing the lesson	4.2 (good)
Learning Media	Clear sound	4.2 (good)
	Image quality	4.5 (very good)
	Duration	4.8 (very good)

Microteaching video production began with determining the biology concept to be taught. The video content was determined to limit the focus to biology learning (Bernacki et al., 2023; Yadav & Chakraborty, 2024). The concept chosen tends to be easy and interesting, such as biotechnology. Video production involves human resources in the field of learning media. The actor in the microteaching video was one of the microteaching practitioners, so it is recognizable and interesting to analyze. Storyboards were prepared by practitioners through the guidance of microteaching lecturers to ensure all basic teaching skills appeared in the video. The video developed is an advantage in this research because many educational institutions do not use this method in microteaching.

Practitioners were assigned to watch video shows outside of microteaching lecture hours. Practitioners can watch it independently. The video is on YouTube, as in Figure 2. Video analysis was carried out during microteaching, but practitioners can access the video via YouTube. Utilizing YouTube, practitioners can access videos anytime and anywhere to explore and listen to video content, which is a practice of basic teaching skills. When practitioners observed a microteaching class, they were given observation instruments regarding the identification of teaching skills, starting from opening to closing the lesson. Research has found new facts that the more often practitioners watch video shows, the more skilled they are in microteaching practices.

Video analysis can be used to find various learning information quickly. Videos show interesting interactive displays, so they are widely used as learning resources (Beal & Steier, 2024; Zhang et al., 2024). Videos can be paused and resumed as desired, so it is easy to discover the strengths and weaknesses of the content. Microteaching practitioners can analyze impressions about basic teaching skills according to their respective learning styles. The video displays the skills of opening and closing the lesson so that practitioners can study each part carefully. The primary purpose of video analysis is to prepare learning tools and teaching practice scenarios. Listening carefully to a learning video is a crucial consideration in overcoming various learning problems (Alamri & Alfayez, 2023; Ogegbo et al., 2024). Video analysis as an assignment requires observation instruments to guide practitioners.

Every practitioner who carries out teaching practice was observed and assessed. The results of the basic teaching skills assessment are presented in Figure 3.
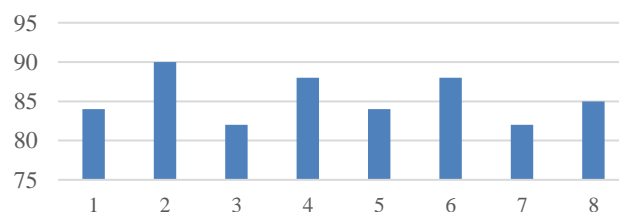
Figure 3. Assessment of Prospective Biology Teachers' Basic Teaching Skills
Description: 1 (Opening Lesson); 2 (Explaining Material); 3 (Managing Classroom); 4 (Guiding Discussions); 5 (Guiding Experiments); 6 (Guiding Learning Outside the Classroom); 7 (Providing Encouragements); and 8 (Closing Lesson).

Table 3. The Comparison of Microteaching Results

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	First Teaching Practice	3.822	82	.2378	.0263
	Second Teaching Practice	4.457	82	.2250	.0248

The main problem with practitioners' skills lies in managing the classroom, while excellence lies in explaining materials. There are eight basic teaching skills for prospective biology teachers that were measured in this study, with a score range of 82 to 90. The scores obtained mean that prospective biology teachers have excellent basic teaching skills for explaining material, guiding discussions, and guiding learning outside the classroom. Data analysis of microteaching scores confirms that practitioners have the readiness to teach at partner schools. The presence of teachers from partner schools has an impact on improving the practice of prospective teachers. At the end of each lecture, there was a reflection on microteaching using photos and recordings. Reflection on learning, which is strengthened by documentation, has a significant impact on improving learning (Astuti, & Drajati, 2022; Charton, 2023; Hußner et al., 2023).

The eight assessment indicators fall into the good and very good categories, showing the positive impact of analyzing microteaching videos repeatedly before teaching practice. A comparison of the assessments of the first and second teaching practices after being analyzed using the paired t-test is presented in Table 3.

After carrying out a comparison test using the t-statistic model, the mean of the microteaching practice score was 3.822 with a standard deviation of 0.2378 and the second practice being 4.457 with a standard deviation of 0.2250. Practitioners with a very good category score had the highest number with 79% (65 practitioners), then practitioners with a good category were 21% (17 practitioners). Learning to apply basic teaching skills can be done by reflecting on how the teaching is done (Sharma et al., 2024). The more frequently practitioners analyze teaching practice videos, the more skilled they are at applying basic teaching skills. Videos provide original footage that can be studied to find various best practices in learning (Lin et al., 2023; Luginbuehl et al., 2023). Research finds new ways to prepare prospective biology teachers skilled in teaching practice through microteaching courses. Research contribution finds new ways to develop the teaching skills of prospective biology teachers. The implementation of the microteaching course for prospective science teachers in the science fields increases the applicability of the curriculum more broadly. The finding is believed to have a real impact on the policy of preparing prospective professional teachers in Indonesia.

CONCLUSION

Microteaching to develop prospective biology teachers' teaching skills under the Next Generation Science Standards criteria can be realized through analysis of teaching practice videos. Before prospective biology teachers undertake teaching practice, they are provided with basic teaching skills and NGSS criteria. Prospective biology teachers' knowledge is used to develop the first teaching plan. The first teaching practice is recorded for analysis as a provision for the second teaching practice. A t-statistic model comparison test strengthens this finding, where the score of the second microteaching practice differs from the first practice. This research found that the practice scores in the second microteaching increased after analyzing the first teaching practice video. The impact of these findings provides solutions to create skillful prospective biology teachers. Based on the research findings, it is suggested that education stakeholders need to implement a prospective teacher skills curriculum that is in accordance with current educational needs for sustainable future education. The development of prospective teacher skills is not limited to following trends but is tailored to the characteristics of the community.

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