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Preservice biology teachers' readiness to teach inquiry lessons: A reflective analysis from microteaching class

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ABSTRACT

It is a necessity in biology classroom to conduct inquiry in order to improve students' scientific knowledge, scientific process, and scientific attitude. Therefore, preservice biology teachers (PBT) need to enhance their ability in teaching inquiry lesson. The aspects of guiding inquiry lesson of PBT need to be assessed to identify which areas need improvement, in order to provide suggestions and enhance the quality of their teaching. While preservice teachers demonstrate adequate skills in facilitating inquiry-based learning**,** the specific quality of each teaching aspect within that inquiry process remains unclear. The purpose of this research is to determine PBTs' skill to teach inquiry lesson through individual practice in microteaching classes. This research is a qualitative descriptive study with quantitative interpretation. Nineteen (19) PBTs in the 5th semester were involved as the sample. Data were collected using observation sheets and questionnaires. This research involved two microteaching lecturers as observers. The results show that PBTs' skill in their ability to interpret experiments' data is not evenly possessed. This suggests that students are already capable of procedurally leading inquiry, while the majority of PBTs are unable to use their biological knowledge and skills to find patterns in interpreting experimental data. This can be a recommendation for educational institutions to make inquiry as an obligatory activity in their curriculum, and they should train PBTs in guiding inquiry through microteaching.

INTRODUCTION

Biology teachers who can teach inquiry-based learning, guide students to be able to ask questions, and continuously improve the quality of their teaching are highly needed. In science education, inquiry-based learning is better than confirmatory learning (Güler, B., & Şahin, 2019). Inquiry is intrinsically context-bound, and context-based education involves extra-situational information from the context, rather than just declarative knowledge from science (Herranen et al., 2019). Inquiry facilitates students to be able to hone their scientific skills and develop collaboration skills (Efendi et al., 2023) and science process skills (Artayasa et al., 2023). Students with the highest PISA scores frequently receive inquiry-based learning experiences in their classrooms (Forbes et al., 2020; Cairns, 2019).

Students in biology class are directed to be able to carry out inquiry including scientific attitudes and methods. The implementation of verifiable lesson has not been able to develop inquiry skills (Setiono et al., 2022). Inquiry-based learning aims to involve students in the process of authentic scientific discovery (Pedaste et al., 2015). Inquiry can help students improve learning outcomes (Patahuddin et al., 2023), developing science process skills (Hidayati et al., 2021), and fostering a scientific attitude (Alviani et al., 2024). Inquiry as a means to ignite students' enthusiasm for science subjects and encourage the acquisition of important scientific process skills through practical activities (Twizeyimana et al., 2024). Unlike the inquiries conducted by scientists, students conduct guided inquiries, which require the guidance of a teacher. The stages of inquiry include formulating research questions, planning investigations, conducting investigations, analyzing data, drawing conclusions, communicating results, and implementing inquiry skills (Widodo, 2024a). Research shows that inquiry is positively related to learning outcomes when involving teacher guidance, and negatively related when not involving teacher guidance. (Aditomo & Klieme, 2020). Therefore, teacher education universities emphasize the importance of preservice teachers becoming accustomed to conducting research so that they can understand the scientific process and attitude.

Teacher education plays an important role in enhancing and influencing the affective and cognitive attitudes of preservice biology teachers (PBT) towards research and developing their research skills. By conducting an inquiry project, PBT will not only teach biology material theoretically, but also train students to think critically, collaborate, and bridge low- and high-ability students (Dobber et al., 2017). Van Katwijk et al. (2021) state that the application of inquiry for preservice teachers provides valuable training, so they develop an inquiry attitude and engage in inquiry-based work. Inquiry guiding skills must start from the habits PBT in conducting inquiry projects (Lammert, 2020)**.** Teachers in inquiry-based learning must think of their actions as guides, not as controllers of the inquiry process (Golding, 2013). Teachers with prior inquiry experience tend to be more able to adopt an inquiry approach, even if they have limited experience in an authentic inquiry education environment (Chichekian & Shore, 2016). The practice of inquiry in the lectures of PBT can improve science understanding and teaching competence as well as increase attitudes or self-efficacy (Strat et al., 2024). Therefore, before teaching students, teachers must have skills in guiding inquiry. PBT readiness to teach inquiry lesson can be trained, evaluated, and reflected in microteaching classes.

Preservice teacher should be given the opportunity to reflect on their performance or learning plan and design it several times through microteaching classes (Kartal & Dilek, 2021). Through microteaching, preservice teacher can increase their creativity, engagement, and lifelong teaching skill development, especially in a resource-limited environment (Mhagama, 2024) and improve the competence of preservice teacher (Pekdağ et al., 2021). Students plan and practice teaching inquiry in small classes and get feedback from their supervisors. Based on this feedback, preservice teacher can identify their strengths and weaknesses in teaching, so that they can continue to improve themselves before teaching at the school (Dayal & Alpana, 2020). The

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supervisor needs to assess the aspects that have not been mastered by the students, in order to be able to provide suggestions, know their readiness, and improve the teaching quality of PBT.

Some previous studies reported how teachers meet challenges and experiences in dealing with the implementation of inquiry (Dorier & Garcia, 2013; Akuma & Callaghan, 2019: Martins-Loução, et.al., 2019). However, there are not many studies that discuss the readiness of PBT in implementing inquiry lessons. Severini, Kožuchová, & Barnová (2024) explained that preservice teachers have sufficient skills in implementing learning using inquiry, but the quality of each aspect of teaching in inquiry has not been explained. Although previous studies have explored inquiry skills in science teacher education, little is known about how well preservice PBT guide specific stages of inquiry, particularly in microteaching settings in Indonesian context. The purpose of this study is to determine the readiness of PBT students in guiding inquiry activities through microteaching classes. By knowing the readiness, we can identify which aspects of teaching inquiry need to be improved. The results of this research can be used as suggestions and references for improving the quality of microteaching lectures or inquiry projects in the Biology Education or Science Education Study Program.

METHODS

This research is a qualitative descriptive study with quantitative interpretation. The population in this study consists of all fifth-semester students of Biology Education program at FPMIPA UPI. The sample of this research consisted of 19 microteaching students. Data were collected through observations conducted by two observers using the inquiry-teaching skills assessment developed by Widodo (2024b). The instrument was developed considering Arends' inquiry steps and activities (Arends, 2015). The instrument for teaching inquiry uses a 1-4 Likert scale with categories low to very good. Each observer conducted an assessment and then the scores were combined and the average was taken. In addition to assessing the readiness to guide inquiry lesson, observers also evaluate their teaching practice competence and awareness using an instrument adapted from the microteaching implementation reflection questionnaire from Ismail (2011). The questionnaire for PBTs is 1 – 5 likert scale from strongly disagree to strongly agree. Quantitative data were analyzed descriptively to determine the PBTs' readiness to teach inquiry lessons.

Before the assessment, PBT creates teaching plans and preparations guided by the lecturer. The biology concepts chosen for their inquiry-based learning are environmental changes, biodiversity, human organ systems, and biotechnology. PBT, as a model teacher, prepares all the tools and materials needed for the inquiry class. Their peers become model students in the learning process. The teacher and model students conduct microteaching according to the scenario that has been created and consulted with the lecturer.

The inquiry conducted in the microteaching class is guided inquiry, thus requiring the teacher's role in its implementation. PBT is said to be able to guide inquiry practices as assessed from the teacher's activities, namely: 1) activating the group, 2) guiding data collection, 3) guiding data result interpretation, and 4) guiding results reporting. PBT activates the group by helping students focus on what they will do. The teacher creates conditions that spark students' curiosity. When the PBT activates the group, the students seem to think and wonder about a phenomenon and then formulate questions. In the data collection activity, PBT guides students through the investigation steps. The teacher guides students in the use of investigation tools and materials. In addition, the teacher guides students in planning the investigation procedure. The teacher verifies the investigation plan by ensuring that the steps to be taken by the students are appropriate. The teacher guides students in the research to gather the evidence needed to answer the research question. Students are not yet skilled in analyzing research data, so the teacher must guide them in finding patterns in their findings. In addition to processing data, the teacher also helps students draw conclusions. The conclusions drawn must answer the research question. PBT guides

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students in presenting results by providing directions on the form and manner of presenting research findings.

RESULTS AND DISCUSSION

Biology teacher candidates design, implement, and evaluate inquiry learning skills practices in front of peers and supervising lecturers. The material chosen by the students must first be approved by the supervising lecturer. Students conduct a teaching practice within 15 minutes. The steps of the inquiry practicum conducted include: 1) students observing the problem or phenomenon, 2) students questioning the problem or phenomenon, 3) students planning the experimental steps, 4) students conducting the experiment, 5) students concluding the experimental results, and 6) students presenting the experimental results (Widodo, 2024a). Both supervising lecturers conduct the assessment using an observation sheet. Data on inquiry lesson guiding skills are presented in Table 1.

Table 1. Descriptive analysis of teaching skills using inquiry lesson

Sample	Lowest Score	Highest Score	Mean	Std. Dev.	Categorization Category	Percentage
19	56	88	79	9,70	Very Good	47%
					Good	42%
					Intermediate	11%
					Total	100%

Based on the analysis (Table 1), the skills of PBT in guiding inquiry show little data variation. This means that the skills possessed by the students are evenly distributed. The students' skills are categorized as very good and good, with only a few in the intermediate category. By following a clear learning model, students can achieve uniform ability in guiding inquiry lesson because they have received instruction on inquiry projects in the previous semester. This ensures that every PBT has the same understanding of the objectives, procedures, and assessments in guiding inquiry. There is a positive relationship between the quality of the inquiry projects they have conducted and their teaching practice (Van Katwijk et al., 2023). PBT has become accustomed to conducting mini research in lectures, so most of them can guide inquiries. Then the data were analyzed to determine the students' skills in each indicator. This analysis is conducted to understand the detailed capabilities of PBT in each step of the inquiry learning process. The results of the analysis are presented in Table 2.

Table 2. Analysis of teaching skills using inquiry lesson skills by indicator

	Indicator of teaching skills using inquiry	Microteaching Class				
		N	Min	Max	Mean	SD
1.	Activating the group	19	75	100	92	11,49
2.	Guiding data collection	19	50	100	82	17,18
3.	Guiding the data interpretation	19	33	67	51	8,45
4.	Guiding the reporting of results	19	50	92	71	14,78

Based on the analysis results, the skill of activating groups has a wide range of values. This means that some PBTs are able to guide and activate groups well, while others are less capable or even unable to perform these skills effectively. PBT that has not yet been able to activate the group is hindered in creating conditions that can make students wonder, not just ask questions. The prompting questions given by the teacher tend to be less stimulating for the group to actively formulate inquiry questions. The questions posed by students in this phase play an important role in science learning based on the inquiry approach. Teachers must utilize the appropriate methods

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and formulations in obtaining and using students' questions for inquiry activities (Herranen & Aksela, 2019). Teachers will find it easier to gain feedback from students if they use effective questioning strategies, focus, appropriate tone, pause, inquiry topic, and question distribution (Shanmugavelu et al., 2020). The important role in inquiry teaching already in the planning phase: how much emphasis is placed on science learning and how much value is put on the students' questions (Herranen & Aksela, 2019).

In the data collection activity, the PBT has been able to guide model students in using the necessary tools and materials and has been able to direct the model students' work procedures according to the questions that arise from the students. However, most PBT have not yet been able to guide students in observation activities. The uneven abilities are evident in how model teachers scaffold the learning process. The teacher's intervention in the domain of scientific knowledge during the investigation process allows students to continue the inquiry phase (van Uum et al., 2016). Teachers can combine hard scaffolding (student worksheets or exercises regarding difficult parts) or soft scaffolding (reference explanations) to assist students in investigative activities (van Uum et al., 2017).

Among the four indicators, the skill of guiding results interpretation is more evenly possessed by students compared to other skills. However, the average of that indicator is smaller compared to the other indicators. This can be interpreted as meaning that compared to all indicators, most model teachers are less able to guide the interpretation of inquiry lab results. Guiding the interpretation in inquiry-based practical work is the most complex and demanding stage because it involves high-level cognitive processes. Compared to activating groups or reporting results, which are more procedural in nature, meaning-making requires the model teacher to guide model students in connecting empirical data obtained from the experiment with broader scientific concepts. Model teachers are required not only to convey information but also to facilitate model students in building deep and meaningful understanding. This requires PBT' ability to make the right questions, spark critical discussions, and help model students identify patterns, relationships, and implications of their findings. Students who performed better in guiding interpretation typically used scaffolding strategies such as prompting questions and visual aids, whereas those with lower scores tended to merely summarize results without linking them to biological concepts. The guidance provided by prospective teachers can influence the communicative approach applied in inquiry-based learning, which affects the opportunities given to students to connect findings with scientific perspectives (Lehtinen et al., 2019).

The skill of guiding the reporting of inquiry results has been well mastered by some PBTs, but is not evenly possessed by all. PBTs who are less able to guide students in reporting inquiry results are due to a combination of factors, namely: lack of practical experience in research, variations in teacher education curricula that emphasize this aspect differently, and the complexity of inquiry methods that require mastery of various skills not always evenly possessed by PBTs. Ideally, teacher education should pay attention to and compare the implementation of inquiry for prospective science teachers in studying scientific concepts and processes or for them to teach through investigation (Strat et al., 2024).

Although it can be said that most students are capable of guiding inquiry-based teaching, we cannot dismiss the findings regarding some students who are still unable to guide inquiry in several aspects. Especially their readiness in interpreting the research data conducted by students. PBTs need to experience inquiry-based learning in their teacher education so that they become accustomed to conducting and applying scientific methods. PBT who are accustomed to and ready to conduct inquiries will be prepared to apply them in the real world of education later. Teachers who have confidence and insight in teaching inquiry knowledge are likely to generate a more positive view of their work context in improving teaching quality (Voet & Wever, 2019).

Each PBT has different backgrounds of knowledge and experience, so the interpretations that occur are also individual. PBT need to give sufficient attention to each model student to ensure that the students can build a solid understanding. Training in inquiry-guiding skills is a

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continuous, systematic, and collaborative process that should not be conducted just once so that preservice teacher can enhance their attention to student needs and improve their research and collaboration skills (Rutten, 2021). Teacher education programs should incorporate microteaching and cooperative lesson preparation activities because of their potential to improve student teachers' lesson design competency (Belıbı Enama, 2021). Microteaching allows PBT to receive the necessary support to develop their teaching and professional skills. Microteaching with colleagues and students proved equally helpful in preparing PSTs for authentic teaching (Wang & Wang, 2025). Based on this, we need to know the role of microteaching in their competence and awareness of teaching practice as part of their readiness. Competence and awareness in teaching practices are presented in Table 3.

Table 3. Competence and awareness of teaching practices

Variable	Mean
Microteaching:	
1. helps me in building my competence in teaching.	4,31
2. helps me develop the teaching skills I will need later.	4,31
3. gives me the opportunity to learn through observing colleagues.	4,08
4. makes me aware of the things that must be possessed to become a great teacher	4,46
5. gives me a valuable opportunity to improve my teaching skills.	4,46
6. encourages me to develop my potential in teaching.	4,23
7. helps me find my strengths and weaknesses in teaching.	4,38

The result shows that PBT believe that microteaching plays a key role in enhancing teaching competence and making them aware of their pedagogical skills (Table 3). PBT strongly agree that microteaching experiences help them identify their teaching strengths and weaknesses in teaching inquiry. These results provide evidence that they gain microteaching experience and consider it beneficial as a training tool. In addition to making inquiry a compulsory lesson in the teacher education curriculum, educational institutions should organize inquiry microteaching to support their readiness to guide experimental teaching. Similar research results indicate that microteaching helps students gain experience, become more confident in teaching, communicating, managing classrooms, planning lessons, and managing teaching time effectively (Nasution et al., 2023; Hamidi, N. B., et al., 2021). Microteaching helps prospective teacher students in preparing their teaching skills (Chotivachira, 2023). Özonur & Kamışlı (2019) state mentioning that the prospective teachers responded positively to microteaching. Kroeger et al. (2024) state that microteaching provides an opportunity to hone skills, serves as a professional development structure, and allows students to build collaborative relationships to improve student learning outcomes.

CONCLUSION

The skills of PBT guiding inquiry lesson are in the very good category, but their ability to guide students interpret data experiment is not evenly possessed. This means that students are already capable of guiding inquiry procedurally, but most of PBTs are not yet able to but most PBTs could not use their knowledge and skills to find patterns in interpreting experimental data. This can be a suggestion for educational institutions to make inquiry a mandatory activity in their curriculum and it is important for them to train PBTs in guiding inquiry through microteaching. This research has limitations regarding the number of students and classes used. It is not yet known how the inquiry guidance skills of biology teacher candidates who are accustomed to inquiry projects compare to those who are not.

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