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PRESERVING TRADITIONAL KNOWLEDGE OF PROSPECTIVE BIOLOGY TEACHERS THROUGH SCIENCE INTEGRATED LEARNING WITH NEXT-GENERATION SCIENCE STANDARDS

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ABSTRACT

This study aims to find the relationship between prospective biology teachers' ethnicity and teaching skills to preserve indigenous knowledge in Indonesia. The research intervention integrates the Science Integrated Learning (SIL) model with NGSS dimensions in the teaching practices of prospective biology teachers. The method chosen was embedded experimental with a quasi-experimental design consisting of three stages: a qualitative stage before, a qualitative stage during, and a qualitative stage after the intervention. The research targets were 60 prospective science teachers in two different cluster universities, each with 30 prospective teachers. Interpretation of quantitative and qualitative data in the form of statistical test results. The analysis of the comparison test using the t-statistic model obtained a difference in the average score of microteaching practice of 0.3, with an average of the first practice of 2,613 with a standard deviation of 0.3024 and the second practice of 2,921 with a standard deviation of 0.3122. The second microteaching practice experienced an increase in scores from the first practice. The study concluded that prospective biology teachers' skills in preserving indigenous Indonesian traditional knowledge can be realized through the SIL Model integrated with NGSS. The research results allow prospective teachers to utilize students' experiences as learning sources and hopefully can contribute on the development of prospective teacher education policies oriented toward preserving Indigenous knowledge in Indonesia.

Keywords: prospective biology teacher; traditional; science integrated learning; next generation science standards

INTRODUCTION

Indigenous knowledge in Indonesia is diverse, but some of it is threatened with extinction due to the modernization of people's lifestyles (AnggadEghenter, 2000; Harahap et al., 2021; hania et al., 2023). Analysis of various studies further strengthens the urgency of preserving Indigenous knowledge through education (Tucker et al., 2018; Zidny et al., 2022). Education is essential to preserve indigenous knowledge as part of the learning materials. Biology learning in Indonesia is essential to conserve Indigenous knowledge because of the worrying threat of extinction (Archila et al., 2021; Shibuya et al., 2023). Biology is a lesson and a process of finding and reconstructing knowledge of society and the environment. Indonesia's indigenous knowledge in traditional knowledge contains scientific studies integrated into biology learning (Sumarni et al., 2022). Integrating culture into biology requires teaching skills that are specifically needed through the preparation of prospective teachers.

The education of prospective biology teachers to preserve Indonesia's Indigenous know-

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ledge has a strategic role that is faster and broader as an impact of teaching duties in schools (Faisal, 2019; Aini et al., 2020; Aletheiani, 2021). The skill of integrating traditional knowledge into learning is given through teaching skills. The problem of biology learning that is difficult for teachers to overcome is integrating local knowledge for contextual learning (Sukmawati & Permadani, 2021; Sukmawati & Permadani, 2021; Sukmawati & Permadani, 2022). Every prospective biology teacher begins by compiling learning tools, learning processes, and assessments. Prospective biology teachers must explore Indigenous knowledge according to their ethnic origins and the environmental conditions of their teaching community (Aragón et al., 2019; Wiyarsi et al., 2023). Various real experiences about local culture must be utilized by exploring and sorting scientific culture appropriate to biology learning materials. Each prospective teacher from a particular ethnic group has knowledge and experience in practicing traditional knowledge.

Several challenges exist in preserving Indonesian Indigenous knowledge through biology learning on prospective teachers' readiness. Biology exists in life, so scientific traditions of society must be used to learn it (Sukmawati et al., 2018; Prajoko et al., 2023). Prospective teachers currently studying are millennials who are increasingly unfamiliar with Indigenous knowledge (Mellado et al., 2008; Wiyarsi et al., 2023). Prospective teachers from different ethnicities have the potential to make their indigenous knowledge as biology learning materials. Teaching skills developed through structured teacher education have programs oriented towards preserving indigenous knowledge. The following are the research problems: (1) Do prospective biology teachers from various ethnicities have differences in indigenous knowledge? (2) How can prospective biology teachers be educated to have teaching skills oriented toward preserving indigenous knowledge? (2) How do prospective biology teachers from various ethnicities prepare for the Next Generation Science Standards (NGSS)?

Preserving Indigenous knowledge through the preparation of prospective biology teachers is urgent because its impact is broad and authentic. Every prospective teacher practices teaching in schools as part of their educational curriculum (Açıkgül, 2020; Meccawy, 2023). Teacher education takes a relatively short time, around four years (Brown et al., 2013). Teaching skills are prepared in a structured manner to integrate traditional knowledge into biology learning so that Indigenous knowledge can be preserved broadly because the interaction of prospective teachers with students at school can be carried out immediately. The needs analysis through a preliminary study found a very urgent problem to be solved regarding a new acceleration strategy to preserve the traditional knowledge of each ethnicity in biology learning. This study aims to find a new method to integrate ethnic traditional knowledge into biology learning. The method found is expected to preserve Indonesia's Indigenous knowledge through education.

The research problems were solved using the stages of the Science Integrated Learning (SIL) model to find the traditional knowledge of prospective biology teachers' ethnicities. The findings were integrated into teaching and learning practice materials to prepare a culturally literate generation. SIL has stages of exploration, concept integration, experiment, analysis, action, and reflection (Demirhan, 2021). Prospective teachers should be aware of the need to explore traditional scientific knowledge because not all indigenous knowledge can be integrated with biology. Prospective teachers' awareness is the initial stage of preserving knowledge according to ethnicity. The selection of indigenous knowledge of prospective teachers gives them the experience of preparing materials integrated into teaching materials. The structured teacher preparation program makes indigenous knowledge inseparable from the teaching material. The future generation of science is developed based on the Next Generation Science Standards (NGSS), which requires them to preserve culture and tradition through education (Lederman, 2014; McComas, 2016; Parmin et al., 2017).

This study aims to find the relationship between prospective biology teachers' ethnicity and teaching skills to preserve Indonesian indigenous knowledge. The research intervention integrates the Science Integrated Learning (SIL) model with NGSS dimensions in the teaching practices of prospective biology teachers. This study is expected to find a method of preserving Indonesian indigenous knowledge through the teaching skills of prospective biology teachers from various ethnicities. The original knowledge used is various traditional knowledge of prospective biology teachers. Its integration into teaching skills begins with semester lesson plans, teaching materials, and assessments. The success of this study anticipates increasingly complex challenges in preparing prospective biology teachers. The millennial generation, prepared to become prospective teachers, has the following characteristics: unstable mentality, lack of patience, and preference for

quick methods. The millennial generation is also weak in learning, lacks patience in doing things gradually, and is easily influenced by digital content on social media. The millennial generation, which becomes prospective teachers, struggles to learn directly in society because they depend on online media information.

Indigenous knowledge is threatened with extinction due to modernization in various areas of life (Coutinho, 2015; Chen et al., 2022; Winburn, 2023). Indigenous knowledge is less popular with the younger generation because it is traditional, so they tend to abandon it. An ethnic group can lose its identity more quickly if the younger generation does not preserve traditional knowledge. The younger generation is prepared to preserve the cultural identity of each ethnic group by integrating traditional knowledge into learning activities (Lewis et al., 2019).

The findings of this study have a significant impact on the preservation of traditional knowledge in Indonesia. They will be a reference for preparing prospective biology teachers in Indonesia and abroad because all countries have the same need to preserve Indigenous knowledge as a national identity. Building on previous research, this study aims to further explore the impact of SIL model integrated with NGSS dimensions on the skills of prospective teachers on preserving indigenous knowledge. Parmin et al. (2019) found that there is a correlation between future science teachers' skill in exploring indigenous knowledge and their science content development abilities. Utilizing the SIL model to explore indigenous knowledge was a successful approach for creating science content.

METHODS

The research objectives were achieved using mixed methods (Creswell, 2012). The method chosen was embedded experimental with a quasi-experimental design consisting of three stages: a qualitative stage before, a qualitative stage during, and a qualitative stage after the intervention. The study required qualitative data before the intervention to refine the intervention and develop treatments and instruments. The study required qualitative data during the intervention to investigate the integration process between the SIL model and the NGSS dimensions as supporting quantitative data. The study required qualitative data after implementing the SIL model with the NGSS dimensions to explain the intervention results and follow up on input from the research targets.

The research targets were 60 prospective science teachers in two different cluster universities, each with 30 prospective teachers. The targets were selected with three criteria: sixth semester, ethnicity, and taking microteaching courses. Sixth-semester students take education courses as a prerequisite for microteaching courses. Prospective biology teachers in microteaching courses are required to do teaching practice. The ethnicity of prospective biology teachers is included in the criteria for reaching various ethnicities in Indonesia.

Data collected in qualitative research before the intervention found traditional knowledge according to ethnicity through the stages of the SIL model. Qualitative data collected during the intervention found an integrated SIL model of NGSS dimensions. Qualitative data collected after the intervention were in the form of responses from prospective biology teachers. Interpretation of quantitative and qualitative data in the form of statistical test results showed teaching skills and the strengths and weaknesses of integrating the SIL model and NGSS dimensions.

Data were collected using a teaching skills instrument to preserve Indonesian indigenous knowledge. This instrument was recently developed specifically to achieve the research objectives. The instrument is novel in its integration of traditional knowledge and NGSS dimensions. The teaching skills measured in this study were adjusted to the criteria of the NGSS-integrated SIL Model, starting from compiling lesson plans, modules, and evaluations. The syntax of the SIL model is very suitable for revealing and reconstructing traditional knowledge related to biology concepts integrated with NGSS dimensions. The research instrument was tested for validity first by involving three experts in biology content, biology learning, and evaluation. The research and product validation instruments were completed online for ease of use.

The purpose of this pretest and posttest is to determine whether there is an increase in students' understanding of planning, implementing, and evaluating biology learning that is oriented towards preserving Indonesian indigenous knowledge. The data analysis techniques used in this research were qualitative and quantitative. The data obtained were analyzed using the normalized gain test formula. The increase in basic teaching skills of prospective biology teachers of different ethnicities is based on scores. The criteria for a gain score of research data results are gain ≥ 0.7 (high), $0.3 \leq$ gain < 0.7 (moderate), and gain

< 0.3 (low). The following are the target achievement indicators: (1) multi-ethnic prospective biology teachers can find traditional knowledge of their respective ethnicities; (2) prospective biology teachers can test traditional knowledge according to ethnicity into scientific knowledge through laboratory testing through the application of the SIL model; (3) A new method to integrate the SIL Model with NGSS dimensions in preparing prospective biology teachers is found; and (4) Prospective biology teachers' teaching skills are developed through the integration of the SIL Model with NGSS dimensions to preserve Indonesia's indigenous knowledge.

RESULTS AND DISCUSSION

Prospective biology teachers' NGSS-integrated teaching skills to preserve Indonesian indigenous knowledge are presented in Table 1.

Table 1. Prospective Biology Teachers' NGSS-Integrated Teaching Skills

NGSS-Integrated Teaching Skills	Number of Students			
	Score			
	4	**3**	**2**	**1**
Investigating knowledge in the environment using various methods	19	38	3	-
Finding traditional knowledge based on empirical evidence	28	26	4	2
Providing an opportunity to review the scientific truth of traditional knowledge	46	10	4	-
Explaining learning materials using models, laws, mechanisms, and theories	31	24	2	3
Explaining learning materials that are connected to traditional knowledge clearly	39	11	6	4
Explaining biology concepts in an orderly manner by integrating traditional knowledge	36	10	9	5
Exemplifying the application of concepts to fulfill the needs of life in society	42	14	3	1
Providing opportunities for students to discuss the application of biology in society	45	12	3	-

Prospective biology teachers' teaching skills were observed using instruments declared feasible by biology education and ethnoscience experts. Prospective biology teachers were observed of basic teaching skills and their skill to explain the scientific basis of traditional knowledge during microteaching practices. During the microteaching, rhe skills of providing opportunities to review the scientific truth of traditional knowledge were the highest. This result means that traditional knowledge is not directly integrated into biology concepts but is confirmed first to ensure that the knowledge revealed is scientific. On the other hand, the skills to investigate knowledge in the environment using various methods were still lacking. Observation results still dominated prospective teachers' methods of uncovering traditional knowledge. They did not optimize interviews and documentation, so their methods are still categorized as less varied. After observing and assessing the teaching skills, this study assessed the teaching skills to preserve the indigenous knowledge of each prospective biology teacher.

The skills of prospective biology teachers were assessed using four categories: highly skilled, skilled, moderately skilled, and poorly skilled. The assessment results are presented in Figure 1.

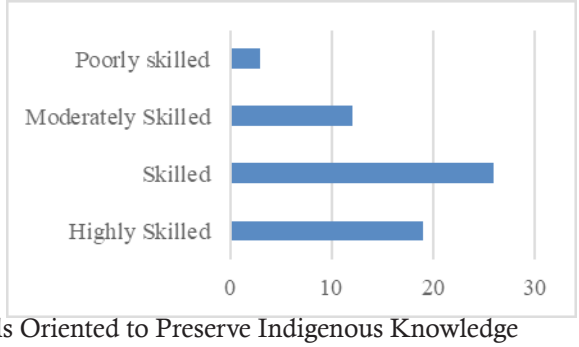

Figure 1. Teaching Skills Oriented to Preserve Indigenous Knowledge

The teaching skills of prospective biology teachers are most dominant in the skilled category (33%), while less skilled teachers are only 5%. Most prospective teachers obtained the skilled and very skilled categories, and microteaching practices are part of integrating the preservation of traditional knowledge from each student's ethnicity. Prospective teachers preserve indigenous knowledge through various teaching strategies. The study found various methods of prospective biology teachers to preserve indigenous knowledge, as in Table 2.

Table 2. Prospective Biology Teachers' Methods to Preserve Indonesian Indigenous Knowledge

Methods to Preserve Indonesian Indigenous Knowledge	Number of Students
Integrating into Learning Materials	43
Student Worksheet	60
Student Observation Sheet	24
Video Observation	19

Most prospective teachers provide assignment activities on preserving indigenous knowledge using student worksheets. The variety of activities in student worksheets ranges from identifying various near-extinct Indigenous knowledge to providing solutions for various Indigenous knowledge that is starting to be abandoned by society. Integrating into learning materials is also widely chosen by prospective teachers. Forty-three prospective teachers directly conveyed how to preserve indigenous knowledge while explaining biology concepts. Prospective biology teachers use the science-integrated learning model in teaching. The syntax of this model includes exploration, concept integration, experimentation, analysis, action, and reflection. Microteaching practice is limited to 20 minutes for each prospective teacher, so syntax implementation starts when the prospective teacher prepares the learning instruments and continues until teaching practice. The analysis of the SIL model application is presented in Table 3.

Table 3. The Application of SIL Model Syntax

SIL Model Syntax	Application
Exploration	Identification of Indigenous knowledge in society Students' initial knowledge
Concept Integration	Biology learning materials
Experiments	Video of biology practice in the laboratory Simulation through demonstration in class
Analysis	Analyzing practice results
Action-taking	Follow-up plan for each student
Reflection	Reflecting on each stage of learning

Learning activities for each syntax are not practiced complexly because the time limit is 20 minutes. All model syntaxes are applied. The SIL model has the advantage of teaching materials first collected through environmental exploration and other learning sources, including electronic media. Prospective biology teachers' skills in exploring learning sources are good, making applying the learning stages to reflection easier.

The microteaching practice was conducted twice for 30 participants. Comparison of microteaching practice after being analyzed using paired t-test as in Table 4.

Table 4. Comparison Test of Microteaching Practice

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Microteaching Practice 1	2.613	30	.3024	.0293
	Microteaching Practice 2	2.921	30	.3122	.0301

The analysis of the comparison test using the t-statistic model obtained a difference in the average score of microteaching practice of 0.3, with an average of the first practice of 2,613 with a standard deviation of 0.3024 and the second practice of 2,921 with a standard deviation of 0.3122. The second microteaching practice experienced an increase in scores from the first practice. The analysis results strengthen

the finding that the more often biology is learned by linking it to traditional knowledge, the more substantial teaching contributes to preserving Indonesian indigenous knowledge.

Preserving national identity by passing on indigenous knowledge is one of the national education goals in Indonesia. The quality of education delivery is highly dependent on the quality of teachers in schools. This study reveals the role of prospective biology teachers in preserving Indigenous knowledge as a national identity. Prospective teachers from various ethnicities influence their role in preserving indigenous knowledge. It was found that the Papuan ethnicity, the origin of a small number of prospective teachers and the most remote ethnic group in this study, still uses various traditional knowledge very strongly. Ethnicities with rapid technological advancement, such as the Javanese, have begun to move away from their native traditions due to modernization and lifestyle. The more modern the lifestyle, the further away from traditional customs that have been proven to be in accordance with sustainability principles (Kumari, 2023; Leonti, 2024). The role of prospective biology teachers in the research was analyzed through teaching practices in microteaching classes.

The study found that prospective teachers' skills in providing opportunities to review scientific truths from traditional knowledge were the strongest. Not all traditional knowledge can be used as biology teaching materials. Prospective teachers provide opportunities for students to review every traditional knowledge revealed during biology learning. Awareness of the use of indigenous knowledge by prospective teachers is evident in microteaching practices. All prospective teachers strive to make traditional knowledge a learning material. Using traditional knowledge as a learning material is a tangible manifestation of prospective teachers' contribution to realizing sustainable life (Mpofu, 2023; Hanazaki, 2024). Prospective teachers provide opportunities for students to discuss the application of biology in society. The opportunity to discuss provides more opportunities for traditional knowledge around students' environment to be revealed. An essential finding of this study is that various traditional knowledge is more easily revealed naturally by students from their respective living environments.

Biology is contextual, so prospective teachers must be prepared to utilize sources of knowledge from the surrounding environment. Contextual nature is more manageable using examples of traditional knowledge that students reveal independently. Research findings connect contextual biology material by exemplifying various types of traditional knowledge. The more often examples of various indigenous knowledge are integrated with biology concepts, the more contextual it is. The skills of prospective biology teachers in exemplifying traditional forms of knowledge according to information received from various learning sources. Students' experiences become a source of knowledge formed in real life in society (Arnold & Willis, 2023; Wardak & Wilson, 2024). Prospective biology teachers must frequently involve students as sources of information for teaching materials, with examples from society. Using traditional knowledge as a learning resource further makes students aware of the diversity of the national culture. Education organized to strengthen indigenous knowledge in a country is a dimension of NGSS.

The preparation of prospective teachers in Indonesia needs to follow the dimensions of NGSS. International standards are following national education goals. The suitability of NGSS with national education goals is based on organizing education to preserve national identity through the preservation of indigenous culture. The demands of technological developments through digitalization must be utilized to preserve national culture (Khanal et al., 2023; Majoko & Dudu, 2023). Knowledge rescue is urgently needed because the millennial generation is increasingly far from past habits that have been scientifically tested for a life in harmony with nature. Prospective biology teachers take a fundamental role by internalizing traditional knowledge in modules and implementing and providing student learning activities by utilizing indigenous knowledge in society. The skills of prospective biology teachers in implementing various research practices because of the lecturers' ability to choose the right learning strategies.

The selection of learning models is adjusted to the characteristics of the material and learning objectives (Goel et al., 2024; Twizeyimana et al., 2024; Marzabal et al., 2024). The microteaching practice aims to provide prospective biology teachers with the skills to apply the teaching stages to preserve Indonesian indigenous knowledge. Indigenous knowledge in this study is limited to traditional scientific knowledge. Not all biology materials can be taught using the SIL model. Appropriate teaching materials examine concepts that can be connected to real life, laboratory testing, and students' experiences before the concept is taught. The SIL model excels because the activity begins with exploring original learning sources and scientific testing. Second, the learning stages have an orientation to preserve traditional knowledge. Selecting a model following the learning objectives allows syntax to be implemented systematically.

The research findings provide a choice of new learning methods for institutions of biology teacher education. New teaching methods from research findings can train linking concepts with indigenous knowledge. The research results provide op-

portunities for students to learn from experiences in everyday life. Organizers of biology teacher education obtain empirical information that is easier to apply. The demands of contextual materials can be linked to traditional knowledge in society. The real impact of research findings on developing teacher education policies oriented towards preserving traditional knowledge in Indonesia. The strategy for preserving traditional knowledge is under national education goals and NGSS dimensions.

CONCLUSION

Mastering concepts is not enough for prospective biology teachers. Teaching skills are not limited to opening and closing lessons but also achieving national education goals. There is a relationship between national education goals and international standards in the NGSS dimension. Biology learning in schools is part of preserving Indonesian Indigenous knowledge. The research results allow prospective teachers to utilize students' experiences as learning sources. The demands of contextual materials can be linked to traditional knowledge in society. The real impact of the research findings is on the development of prospective teacher education policies oriented toward preserving Indigenous knowledge in Indonesia.

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