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Sustainable science learning model integrated with indigenous values to promote climate change prevention among prospective science teachers

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ABSTRACT

Science learning in schools plays a strategic role in advancing the achievement of the Sustainable Development Goals (SDGs) in Indonesia. SDG 13 addresses climate change, integrated with SDG 4 through the provision of quality education. Instilling a lifestyle of climate change prevention will enhance harmony with the environment. The purpose of this study was to measure the impact of a sustainable science learning model integrated with the indigenous values of prospective science teachers to instill a lifestyle of climate change prevention. The research method used was a mix of quantitative and qualitative methods, collecting quantitative data on the impact of a climate change prevention lifestyle and qualitative data on prospective teachers' abilities to prepare climate change prevention lessons. Results obtained above a score of 4.00 indicate that it has a real impact on prospective teachers' climate change prevention activities. The ability of prospective teachers to prepare lessons, with an average result of 4.22, indicates it is in the good category. The sustainable science learning model, integrated with the indigenous values of prospective science teachers, has a real impact on instilling a lifestyle of climate change prevention.

Keywords: impact, sustainable science learning, indigenous values, prospective science teachers, climate change prevention lifestyle

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INTRODUCTION

The challenge of preparing prospective new teachers in Indonesia is becoming increasingly complex, as the need to address the widespread negative impacts of climate change driven by human activities grows. The education of prospective teachers as part of sustainable human resource development is designed to foster professionalism and enable them to make a real contribution to government programs that align harmonious living with the environment. According to data from the Meteorology, Climatology, and Geophysics Agency in 2025, Indonesia ranked sixth hottest, with an anomaly value of 0.38 °C. The rate of climate change in Indonesia is very rapid, with average air temperatures since 2024 at 27.5°C, an increase of 0.8°C from 1991-2020. The SDGs play a strategic role in advancing human resource development in Indonesia (Wahyudi et al., 2025; Iskandar, 2026; Sianturi et al., 2026). SDG 13, on climate change, is integrated with SDG 4 through the provision of quality education. Instilling a lifestyle of climate change prevention will foster harmony between life and nature.

Education makes a significant contribution to climate change prevention through teachers' roles in teaching. Teachers can provide students with repeated, ongoing, real-world experiences to cultivate habits for preventing climate change. The preparation of prospective science teachers is being developed to meet the needs of the future generation of scientists (Wiyarsi et al., 2024; Summers, 2024). Prospective teacher training, oriented toward climate change prevention skills, utilizes various proven local traditions and harmonizes the lives of past communities with nature. Prospective teacher educators need to assess their readiness to design learning that utilizes locally based content for environmental sustainability (Chang et al., 2024; Sarıtaş & Kızkapan, 2024;

Sianturi & Nababan, 2026). Prospective science teachers come from diverse ethnic backgrounds. Each ethnic group possesses traditional knowledge or indigenous values derived from culture and traditions that harmonize with nature (Parmin et al., 2016; Zidny et al., 2023; Michie et al., 2023). Traditional communities maintain Indigenous values because they enable them to live in harmony with nature (Maluleke et al., 2024). A sustainable science learning model integrated with indigenous values has been developed to instill a lifestyle of climate change prevention through science learning.

The sustainable science learning model's syntax includes identifying ethnic traditions, designing climate change prevention plans, practicing the traditions of ethnic origin, analyzing the results of these practices, their impacts, and reflecting on them. Traditions maintained by traditional communities that have been proven to enable a life in harmony with nature are identified. The traditions revealed have become part of each ethnic group's lifestyle. Practices can be conducted individually or in groups, indoors or outdoors. Familiarizing themselves with traditional knowledge fosters respect for traditions (Baron-Aguilar et al., 2025). Practices are sustainable habits that aim to change behaviors that contribute to climate change. The results of the practices are reported in writing, accompanied by complete documentation. After obtaining facts and data from the practices, they are analyzed by connecting scientific theory with ethnic traditions, ethnic traditions with climate change prevention, and maintaining the continuity of traditions with modern life. The strong influence of climate change prevention practices that benefit the community include limiting the use of fossil fuels, conserving clean water, consuming local foods, planting and caring for trees, maintaining local biodiversity, and other activities.

The purpose of this study was to measure the impact of the SLL model, developed by integrating indigenous values, to instill a climate change prevention lifestyle in prospective science teachers. The model's impact on basic microteaching skills focused on limiting fossil fuel use, conserving clean water, consuming local foods, planting and caring for trees, and preserving local biodiversity. The success of this new learning model can be determined by its broad applicability (Zamri et al., 2023; Saplan et al., 2024). Changing lifestyles to instill climate change prevention through microteaching involves measuring learning tools, learning implementation, and observed changes in attitudes. Microteaching skills are used to train prospective teachers to prepare a future generation that contributes to climate change prevention (Parmin et al., 2024). The future of science in Indonesia is realized by preparing prospective teachers skilled at integrating the potential of natural resources with indigenous Indonesian culture (Parmin et al., 2022).

The use of this model requires measurement to analyze the level of syntax applicability, instructional impact, and social impact. The applicability of the SLL Model as a new model is determined by how easily prospective teachers can learn from it. Ease of use of the model is part of the novelty analyzed during the research process. The instructional impact of the model's use is measured by instilling a lifestyle for climate change prevention. The limits of climate change prevention measured include five habits that serve as indicators of the model's successful use. During the model's use, prospective teachers are expected to interact reciprocally with lecturers and with students. Social interaction is part of the analysis, as measured by the model's impact.

METHOD

The method used to measure the impact of the sustainable science learning model, integrated with the indigenous values of prospective science teachers, on instilling a climate change prevention lifestyle was a mixed-methods design (Creswell, 2012). The study used an embedded mixed-methods design consisting of qualitative data collection before, during, and after the intervention, supported by quantitative measurement of five climate change-prevention lifestyle indicators. The research required qualitative data before the model was used to refine the intervention, develop the treatment, and develop the instrument. The study collected quantitative data on five indicators of climate change-prevention lifestyle. These five lifestyles are: limiting fossil fuel use, conserving clean water, consuming local foods, planting and caring for trees, and preserving local biodiversity. Qualitative data were collected from microteaching observations for each model syntax used.

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The research participants were prospective science teacher students attending microteaching lectures in two study groups of 50 students each. Specifically, the research began with the development of a data collection instrument. The instruments developed specifically follow the SSL Model and include: (1) assessing microteaching learning tools, (2) measuring five indicators of a climate change prevention lifestyle, and (3) observing teaching skills in the microteaching process. The specially developed instruments will be validated by learning evaluation experts with a track record of teaching microteaching. The involvement of experts as observers in lectures is an innovation to address the problem of the weak applicability of similar products, based on various research experiences. Experts will directly observe the skills of prospective Science teachers in climate change prevention.

Data were collected from the assessment of microteaching learning tools, consisting of lesson plans, teaching materials, worksheets, and assessments. Lesson plans are assessed for their presentation standards and model integration. Teaching materials and learning activities are assessed for conceptual accuracy and adherence to the model syntax. The worksheets are part of the model syntax. Student-prepared assessments from microteaching practice are used to evaluate learning success. Data analysis is carried out by processing the validation sheet using a Likert scale. The achievement level qualifications in this study used three percentage ranges: very good (86-100), good (70-85), and less good (<70). The data were analyzed descriptively by referring to the calculation results of each assessment item.

FINDINGS AND DISCUSSION

Findings

Prospective teachers attended a course on the sustainable science learning model before practicing in microteaching sessions. Their practice using the model was observed to assess the model's applicability. The results of the applicability analysis are shown in Table 1.

Table 1. Applicability of the syntax of the sustainable science learning model

Syntax	Score	Category	Description
Identification of ethnic traditions	4.5	Very Good	Ethnicity of prospective teachers who are practicing
Climate change prevention plan	4.2	Good	Worksheet on the use of ethnic traditions
Practice of using ethnic traditions	4.3	Good	Practice in the laboratory and outdoors
Analysis of practice results	4.0	Good	Interpretation and facts obtained
Reflection	4.2	Good	Reviewing the strengths and weaknesses of the learning implementation

Observers found that the interns used examples from their own ethnic traditions to capture students' attention during the microteaching class. They used a video showing the traditional method of selecting trees for felling, replacing the area of the felled tree with two new trees of the same type. Students were asked to identify any traditions related to preventing environmental damage around their homes. The identification process continued with the creation of a practice sheet about a tradition commonly practiced in traditional communities. The practical practices included tree planting, waste sorting, distributing fish seed, and maintaining clean water sources. The model analyzed the results of the practical activities through interactive discussions on their positive impacts on climate change prevention. The model implementation concluded with a learning reflection to identify the strengths and weaknesses of the learning activity. The main weakness lay in the identification process: some students found it difficult to identify the traditions of each ethnic group in real life, even though they were readily available online.

The 57 interns who taught in the microteaching class were interviewed to reveal how they practiced climate change prevention in their daily lives. Five main lifestyle indicators were measured in this study. The results of the analysis of climate change prevention lifestyles among prospective science teachers are shown in Table 2.

Prospective teacher students demonstrated a strong commitment to environmental protection, particularly in aspects that directly conserve resources, such as water. Future development can focus on strengthening local food consumption habits and integrating a deeper

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understanding of the carbon footprint so that concrete actions, such as tree planting, align with other daily lifestyle choices. Prospective teachers have a climate change prevention lifestyle that has become a habit, ranging from very common to unfamiliar: conserving clean water, protecting local species, planting trees, conserving fossil fuels for vehicles, and consuming traditional foods.

Table 2. Analysis of climate change prevention lifestyles of prospective science teachers

Lifestyle	Correlation Value (Pearson)				
Fossil Fuels	1.00	0.21	0.37	0.12	0.12
Conserving Water	0.21	1.00	0.32	0.11	0.36
Local Food	0.37	0.32	1.00	0.32	0.17
Planting Trees	0.12	0.11	0.32	1.00	0.46
Biodiversity	0.12	0.36	0.17	0.46	1.00

Internship students have a less habitual lifestyle of conserving fossil fuels for daily mobility and are still less accustomed to traditional foods. Awareness of conserving clean water in their residential environment is the most common of the five indicators. An analysis of each aspect of the prospective teacher lifestyle is shown in Figure 1.

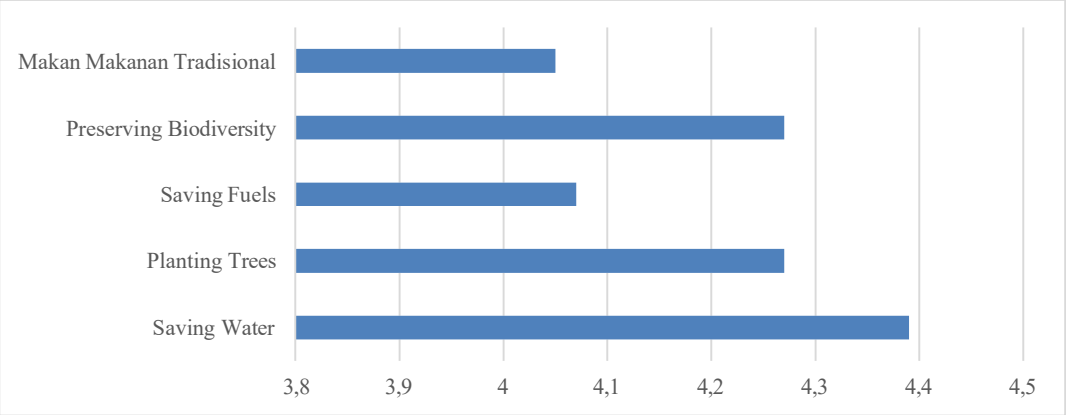


Figure 1. Lifestyle Assessment Results for Prospective Science Teachers

All aspects ranged in score from 4.0 to 4.4, indicating a positive level of sustainable lifestyle habits among prospective educators. However, there were some interesting correlation findings, with the strongest relationship (0.46) between tree planting and biodiversity. Prospective teachers who actively planted trees after the model were implemented tended to have a higher level of concern for preserving biological species. Concrete actions in the field further strengthened overall ecosystem awareness. There was a positive relationship between limiting fossil fuel use and consuming local food, indicating that students had a holistic understanding of how to reduce their carbon footprint, both in their mobility and in their diet. Prospective teachers who cared about biodiversity also tended to be more disciplined in water conservation, indicating a link between understanding ecosystem functions and water resource conservation.

An assessment of microteaching learning tools, including lesson plans, teaching materials, worksheets, and individually prepared assessments, was conducted. Assessment focused on integrating climate change prevention into each learning tool. The evaluation tool analysis yielded an average of 4.38, and the lesson plan, with an average of 4.37, had the highest score, indicating that the two aspects were the strongest in shaping a climate change prevention lifestyle. The teaching material had an average of 4.22, indicating a strong impact but not stronger than the other two aspects. The model's implementation was determined by the ease of using the learning syntax. Practitioners found it easy to implement each learning activity according to the syntax as a result of the model-usage course. Practitioners received materials from the model development team on getting to know the model and its syntax before using the model. The learning stages were introduced in detail; each syntax is interrelated and continues through to the final syntax.

Discussion

The syntax of the sustainable science learning model has good to excellent implementation levels. The new learning model is easy to understand thanks to the descriptions in the model usage

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guide and the learning activities, which are structured in easy-to-understand operational language. The easy-to-understand language assessment aligns with the product's expert validation during the model's development before implementation. The new model demonstrates ease of implementation and a positive impact from the model usage course conducted. Knowledge and skills regarding learning models in science learning are crucial for achieving student-centered learning success indicators (Stammes et al., 2026; Wu et al., 2026; Zheng et al., 2025). The model usage course, delivered by the development team, included presentations introducing the model, from its philosophy to its success indicators. The primary emphasis was on implementing the syntax, characterized by adopting a lifestyle focused on preventing climate change.

The implementation of the model also confirms the relevance of connecting science teacher education with indigenous knowledge, NGSS-oriented preparation, and real-life science application. Parmin and Trisnowati (2024) showed that indigenous knowledge can be integrated into the curriculum for preparing prospective science teachers according to NGSS. Meanwhile, Parmin and Khusniati (2021) found that pre-service integrated science teachers still need stronger preparation in concept mastery and in teaching students how to apply science concepts in daily life. Therefore, the sustainable science learning model in this study strengthens previous findings by providing a more practical learning structure that connects indigenous values with climate change prevention practices. In this sense, the model does not only introduce indigenous values as cultural content but also positions them as learning resources that can guide prospective science teachers in designing concrete and sustainable climate change prevention activities.

Analysis of observations during the model's use revealed its superiority in promoting a lifestyle that helps prevent climate change. The model's syntax has made it easy for both teachers and students in microteaching classes to engage in active learning. This ease of engagement stems from identifying the habits of each participant's ethnic background. Ethnic differences shape traditional communities' past practices for preventing environmental damage. Teaching materials are specifically developed to integrate the results of identifying the various traditional knowledge communities' approaches to living in harmony with nature. Learning resources from traditional communities can help restore traditions through modern education (Tran et al., 2025; Steinert, 2025). A key finding from the analysis of learning tools is that realizing a climate change prevention lifestyle can be achieved by incorporating the results of identification and real-life examples of various traditional community knowledge into the learning tools used by prospective science teachers.

Initial courses using the model shaped prospective teachers' knowledge and skills because the model is unfamiliar. Learning strategy courses need to become a habit in prospective teacher education (Kuhn et al., 2025). The learning materials developed by the interns differ from those typically used in microteaching because they integrate climate change prevention. Lesson plans are characterized by learning activities that use literature drawn from traditional community traditions. Contextual learning resources from community life become new characteristics that serve as examples of study in the teaching materials. This characteristic is supported by Zidny et al. (2021), who found that indigenous science can provide relevant contexts and contents for science learning and education for sustainable development. Their study on the Baduy community showed that local practices related to agriculture, medicine, natural dyes, household materials, renewable energy, and astronomy can be connected to modern science concepts. This supports the argument that community-based learning resources can make science teaching more contextual, meaningful, and sustainability-oriented. Learning to restore traditions is made easier by describing how traditional knowledge integrates with modern scientific knowledge (Zhou et al., 2026; Tarimo et al., 2025; Nasu, 2025). The model provides space to develop skills in exploring and using indigenous community knowledge through worksheet activities. This is in line with Mandikonza (2019), who showed that indigenous knowledge practices can be used as contextual starting points for learning curriculum science concepts. In that study, student teachers used familiar community practices to prepare lesson plans and peer-teaching activities, showing that indigenous practices can help move science learning from everyday contexts to formal scientific concepts. Therefore, the worksheets in this model are important because they guide prospective science teachers to reconstruct indigenous knowledge into teachable science content. The skills practiced through the worksheets incorporate indigenous values into a lifestyle of

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climate change prevention.

The integration of indigenous ethnic values among prospective science teachers impacts the instillation of a lifestyle of climate change prevention. This result strengthens previous studies showing that knowledge and attitudes alone are not sufficient to produce sustainable behavior. Funa et al. (2022) found that favorable knowledge and attitudes toward education for sustainable development do not always generate positive behaviors. Nayan et al. (2020) also found that pre-service teachers' knowledge and attitudes toward climate change mitigation and adaptation were high, while their skills and practices remained at a moderate level. These findings indicate that climate change education should not stop at strengthening knowledge and attitudes. It also needs structured learning experiences that help prospective teachers transform knowledge and attitudes into practical and sustainable climate change prevention habits.

The role of indigenous values in this model is also related to the formation of environmental attitudes. Aisyah et al. (2024) emphasized that pre-service teachers' attitudes toward climate change are shaped by value orientation and educational experience, and that environmental education for pre-service teachers needs to be comprehensive and interdisciplinary. Therefore, integrating indigenous values into sustainable science learning can strengthen not only prospective teachers' knowledge but also their value-based habits related to climate change prevention. This is important because the model does not merely ask prospective teachers to understand environmental issues but also guides them to practice climate change prevention through activities such as limiting fossil fuel use, conserving clean water, consuming local foods, planting and caring for trees, and preserving local biodiversity.

The strategy of integrating traditional knowledge significantly contributes to preserving various traditions that have proven harmonious with nature (Chao et al., 2025). The research findings recommend that prospective teacher education providers utilize traditional knowledge appropriate to prospective teachers' ethnic backgrounds, integrating it into learning materials. Experience with the stages of using the SSL Model can provide valuable input in preparing prospective teachers to serve as agents of climate change prevention. The model's impact on lifestyle was strengthened by the model-use course conducted before microteaching practice, as the course uses the model with prospective teachers before they practice through microteaching.

CONCLUSION

The impact of the Sustainable Science Learning Model, integrated with the indigenous values of prospective science teachers' ethnic origins, can strongly instill a lifestyle of climate change prevention. The integration of indigenous traditions from past communities into the model, learning tools, and practice through microteaching is categorized as high or good because the score is above 4.22 out of a maximum of 5.00. The treatment course on the model's use for prospective teachers before practicing through microteaching is the strongest source of impact and should therefore be implemented more widely in preparation classes for prospective science teachers.

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