Environmental Awareness of Prospective Chemistry Teachers as Character Values of Environmental Education

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Abstract: Environmental awareness among preservice teachers is an essential component of environmental education, yet its development is often influenced by limited knowledge and insufficient integration of environmental issues in higher education. This study aims to analyze the level of environmental awareness of prospective chemistry teachers based on three dimensions: knowledge, attitude, and behavior. A quantitative descriptive design was employed involving 127 students selected through purposive sampling. Data were collected using a validated questionnaire with a 5-point Likert scale, and analyzed descriptively by determining mean scores and category levels. The results showed that environmental awareness was in the moderate category for the knowledge aspect (M = 3.31) and in the high category for both attitude (M = 3.72) and behavior (M = 3.67). These findings indicate that students demonstrate positive attitudes and environmentally responsible behavior despite having limited conceptual knowledge. The study concludes that strengthening environmental knowledge through integrated instructional strategies, exposure to scientific literature, and collaborative environmental programs is essential. Further research should explore intervention-based models to enhance environmental literacy and examine factors influencing awareness development across different teacher education programs.

Keywords: Attitude; Behavior; Environmental awareness; Environmental education; Knowledge

Introduction

A society that cares deeply about the environment can be achieved by running programs that can be made more interesting and can involve more schools without having to wait a long time. The environmental education program or known as the Adiwiyata program by the government for schools has been implemented since 2006 until now. Several schools have succeeded in bringing positive changes to students, parents and the community in general (Indahri, 2020). A more interesting program that can be carried out is in an integrated and integrated manner in the learning program, school environment, learning activities in and outside the classroom, through the formation of attitudes and in a fun way and involving students actively (Rahmani & Rahiem, 2023). The importance of collaboration between various parties to create more transformative and sustainable environmental education, such as research by Al-Hail et al. (2021), states that direct involvement of parents and communities in environmental education programs in schools can increase student participation and strengthen awareness and responsibility for the environment.

Based on government program data, in 2023, there will be 30 senior high schools and vocational schools that

care about and have an environmental culture towards independent Adiwiyata and 30 senior high schools and vocational schools towards national Adiwiyata (Badan Penyuluhan dan Pengembangan Sumber Daya Manusia, 2024). This shows that there are still limited schools that fulfill environmental education programs due to lack of collaboration. Schools that provide facilities through the role of teachers in environmental education and support environmental activities, as well as collaborating to involve the role of parents and local communities tend to have an impact on students so that they become active and care about the environment. This is an indication of the importance of collaboration between educational institutions, families, and communities in forming attitudes and behaviors that support the environment among students (Rahayu et al., 2024). In line with this, research by Priatmoko et al. (2023) emphasized that collaboration between schools, parents, and local communities has an important role in strengthening environmental awareness and improving student learning outcomes, creating a more inclusive learning environment and encouraging environmental protection habits from an early age.

The main task of the teacher is to increase the level of awareness of character values in students to always maintain the environment in the school to create a green environment. In the character value of collaboration, guiding students by getting students used to working together to clean the school environment. So that a sense of empathy arises when seeing undesirable conditions seen by the eye, then that feeling encourages students to maintain the environment (Nugroho, 2022). There are also supporting factors for teachers to teach environmental education, namely the belief in long-term benefits for students and the community and the school environment.

Environmental awareness of prospective chemistry teachers has a crucial role in shaping collaborative character values in environmental education. This effort lies in the need to increase the involvement of prospective teachers in internalizing sustainability values so that they can later be applied in learning at school. Environmental education programs, such as Adiwiyata, aim to instill responsibility and concern for the environment with a collaborative approach involving teachers, students, and the community (Pradini et al., 2018). Prospective chemistry teachers who have environmental awareness can integrate the concepts of environmental chemistry, waste management, and environmentally friendly practices into their learning, thereby contributing to the creation of a generation that cares more about the environment (Tobib et al., 2024). However, the limited number of schools that have successfully achieved Adiwiyata Mandiri and National status shows that there are still

challenges in building cooperation between educational institutions, the community, and the government. There are significant differences in attitudes towards the environment between Adiwiyata and Non-Adiwiyata school students (Tunga & Jumadi, 2022). Therefore, prospective chemistry teachers must play an active role in instilling environmental awareness through project-based learning methods, sustainability experiments, and collaboration or synergy with various parties. A study by Paristiowati et al. (2022) emphasized the importance of developing environmental awareness competencies through a project-based learning model involving collaboration with national and international universities, which significantly increased the involvement of prospective chemistry teachers in environmental education. Thus, environmental education is not only part of the curriculum, but also a strategy in forming a collaborative character that supports the creation of a society that is more responsible for the environment.

Although previous studies have emphasized the importance of environmental education and the collaboration between schools, parents, and communities, research that specifically measures the environmental awareness of prospective chemistry teachers across three dimensions—knowledge, attitude, and behavior—remains limited. The novelty of this study lies in its analytical approach, which simultaneously integrates cognitive, affective, and psychomotor dimensions to construct a comprehensive profile of environmental awareness among preservice chemistry teachers, offering deeper insights compared to studies that focus on only one or two aspects.

This research is important because prospective chemistry teachers play a crucial role in transferring environmental literacy to future generations. An imbalance in their environmental awareness—such as having strong attitudes and behaviors but insufficient knowledge—may hinder the effective integration of environmental issues into classroom instruction. Furthermore, the current global environmental crisis demands educators who not only possess strong conceptual understanding but also have the capacity to embed sustainability values in their teaching practices. Therefore, the findings of this study provide an empirical foundation for curriculum development, teacher education programs, and instructional strategies that more effectively integrate environmental issues.

Method

Time and Location of Research

This research was conducted from February to April 2025 at the Chemistry Education Study Program, Medan State University.

Type of Research

This study employed a quantitative descriptive design aimed at measuring environmental awareness based on knowledge, attitude, and behavior dimensions.

Research Methods

Purposive sampling was used to select 127 prospective chemistry teachers who had not taken environmental chemistry courses. A structured questionnaire served as the primary data collection instrument.

Research Stages

The research procedure consisted of several sequential stages to ensure the validity, reliability, and accuracy of the environmental awareness measurements like Figure 1.
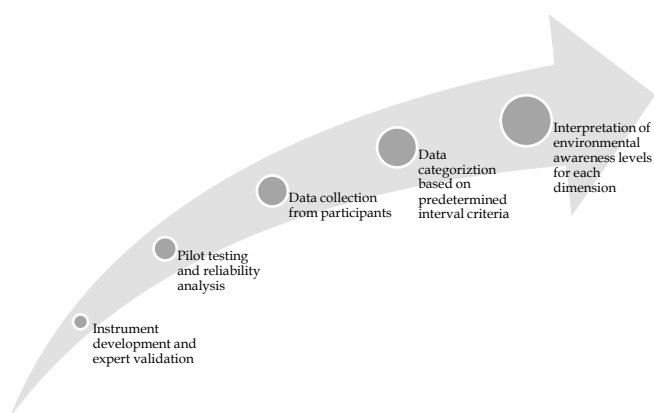

Figure 1. The research procedure

The process began with instrument development and expert validation, during which the questionnaire items were constructed based on theoretical indicators of knowledge, attitude, and behavior, and subsequently reviewed by experts to ensure content relevance and clarity. Following this stage, a pilot testing and reliability analysis was conducted on a small group of students to evaluate item consistency and refine the instrument based on statistical outputs.

After confirming the reliability of the instrument, the study proceeded to data collection from participants, involving 127 prospective chemistry teachers selected through purposive sampling. The responses obtained were then subjected to data categorization based on predetermined interval criteria, allowing each dimension to be classified into levels ranging from very low to very high. Finally, the categorized data served as the basis for the interpretation of environmental awareness levels for each dimension, enabling a comprehensive understanding of the students' environmental knowledge, attitudes, and behaviors.

Data Analysis

Descriptive statistics were employed to calculate the mean scores and classify each dimension into predetermined categories ranging from very low to very high. Instrument validity was examined through item–total correlation analysis ($p < 0.05$), while reliability was confirmed with a Cronbach's Alpha coefficient of 0.943. The instrument is suitable for use because it has been judged to be both valid and reliable (Faisal et al., 2023; Rashifah et al., 2023). The classification intervals were defined as follows: very low (1.00–1.80), low (1.81–2.60), medium (2.61–3.40), high (3.41–4.20), and very high (4.21–5.00).

Result and Discussion

Knowledge Dimension

Adji et al. (2023) adapted Bloom's taxonomy into a multi-construct approach that Factual knowledge asks student to organize things or communicate understanding systematically as character. Character as part of personality reflects the whole personality, including mentality (knowledge), attitude, and behavior (Isnaini & Fanreza, 2024). The knowledge aspect is assessed based on six aspects, namely recognizing, understanding, applying, analyzing, assessing, and creating. The results of measuring the knowledge aspects are presented in Figure 2.
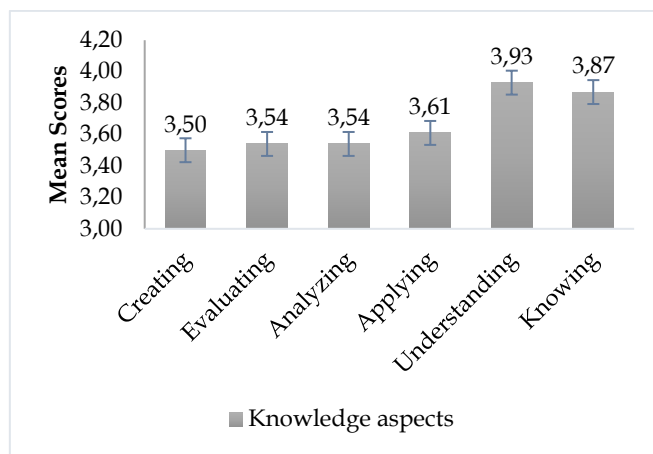

Figure 2. Results of measurement of student knowledge aspects

Based on Figure 2, it can be seen that the average response of students in the aspect of knowing and understanding shows a value of 3.93. This response shows that students are able to recognize environmental issues and understand the causes of environmental pollution and understand the importance of preserving the environment through an environmental chemistry approach. This shows that the environmental knowledge possessed by students can increase students'

awareness of environmental issues (Santosa et al., 2024). A good understanding of environmental pollution can also increase environmentally friendly behavior (Fubani et al., 2024). Research by Burgos-Espinoza et al. (2025) shows that environmental knowledge significantly influences environmental awareness attitudes and behaviors in engineering students in Mexico. This is in line with the results of previous studies that emphasize the importance of environmental education in shaping environmental awareness behavior among students. Good knowledge and understanding of environmental issues, their causes and impacts play an important role in increasing environmental awareness among students. Through an environmental chemistry approach, students not only gain theoretical studies, but are also motivated to care more and contribute to efforts to preserve the environment.

The data also shows that the aspects of analyzing, evaluating and creating are still relatively high with an average of 3.5. This shows that in general students are able to detect, conclude and create new ideas to increase environmental awareness, such as the use of single-use plastics, classification of waste types and creative media education. This can happen because of the application of material in analyzing, evaluating and generating new ideas. As the results of research by Prihatmadji et al. (2024) shows, environmental education and plastic waste management significantly increased students' environmental awareness which supports pollution reduction. One of the main factors in the high environmental awareness among prospective chemistry teachers is the application of in-depth learning materials related to the ability to analyze, evaluate, and create new ideas with research that supports this. Thus, the performance of prospective physics teachers in addressing Higher Order Thinking Skills questions can still be considered inadequate (Arafah et al., 2022). The importance of integrating environmental-based learning and the application of creative analytical approaches in the curriculum to form prospective chemistry teachers who are more critical, caring, and innovative in responding to environmental issues.

Attitude Dimension

In addition to the knowledge aspect, attitudes that reflect awareness and responsibility as well as motivation to participate are also indicators of environmental awareness of prospective chemistry teachers. As stated by Pahlevi et al. (2022) that self-awareness and awareness of responsibility influence each other in the formation of students' ethical behavior. Both of these aspects are considered important in developing student character. Research by Buraerah (2023) shows that there is a positive relationship between attitudes and motivation in improving

environmental quality. Other studies also reveal that there is a positive relationship between environmental care attitudes and participation in maintaining the environment (Anggraeni et al., 2021). Research by Uzorka et al. (2024) shows that student involvement in environmental activities can increase a sense of responsibility and ownership of environmental sustainability which can encourage active participation in environmental awareness activities. This attitude shows a person's readiness to consciously take action related to various environmental issues, such as laboratory waste management, realizing the importance of environmental education in learning and believing that collaboration can increase environmental awareness. The accountable factor emerges as the most dominant situational influence, whereas habituation and practice represent the strongest dispositional influences (Hillary et al., 2023). There are several aspects of attitude including responsibility, awareness, motivation and participation. The results of measuring the attitude aspects are presented in Figure 3.
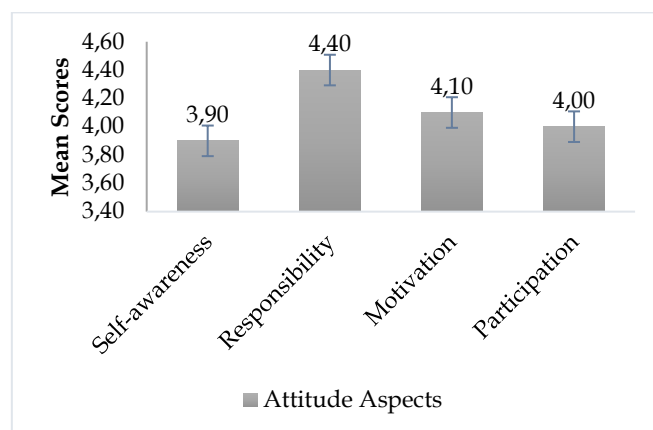

Figure 3. Results of measurement of student attitude aspects

Being responsible for the environment as a form of environmental awareness is an important part of realizing collaboration to care for and maintain the sustainability of nature. Based on the measurement results, the highest indicator reached 4.4 which looks very high in the aspect of responsibility. Research by Acevedo Flores et al. (2024) stated that students who demonstrate environmentally conscious behavior tend to be active in activities such as saving resources, recycling, and participating in environmental conservation, which reflects high environmental awareness and responsibility. In addition, research by Eraslan et al. (2024) highlighted that environmental awareness contributes significantly to environmentally friendly behavior among students, including waste reduction and resource conservation. These findings emphasize the importance of integrating environmental

education in forming an attitude of ecological responsibility among students. A person's attitude of responsibility towards the environment reflects awareness in maintaining the sustainability of nature with real behaviors such as waste reduction, environmental conservation, and participation in environmental conservation activities. Amin et al. (2023) show that the level of preparedness of prospective teachers and science teachers in facing ecological and sustainability challenges is at a high level. The high indicator of responsibility shows that this awareness has grown strong and become an important foundation in realizing collaboration to maintain the environment sustainably.

The average obtained in the self-awareness aspect is slightly different, namely 3.9. Indicating agreement with environmental issues. Students already have high self-awareness as an attitude to interact positively with existing environmental issues. Self-awareness has a significant influence on attitudes of caring and preserving the environment (Mangensiga et al., 2023). Awareness of the importance of protecting the environment, the ability to identify environmental problems, readiness to take action in preserving the environment and actively participating in conservation activities are steps that can be taken in implementing an attitude of environmental awareness. Instilling a caring character for the environment can make students have self-awareness in managing the surrounding environment and being responsible for the interests of the future (Sawitri et al., 2024). Research by Nguyen et al. (2024) show that self-awareness plays a role in encouraging environmental awareness among students in ASEAN countries, including Indonesia, by showing that social, family, and university environmental factors significantly influence students' environmental awareness behavior through their self-awareness.

Behavior Dimension

In addition to the knowledge and attitude aspects, prospective chemistry teachers who have environmental awareness tend to take real actions in supporting environmental education as a character value. These behavior aspects include practice, collaboration and support. Sustainable innovation practices involving collaboration between government agencies and other institutions contribute to environmental protection (Ardhiyansyah et al., 2023). Environmental education can also increase environmental awareness and encourage pro-environmental behaviors (Pratomo et al., 2023). Research by Diaz et al. (2023) show that environmental educatdiazion positively influences students' environmental awareness, by emphasizing the integration of environmental education into the curriculum to encourage real action in environmental

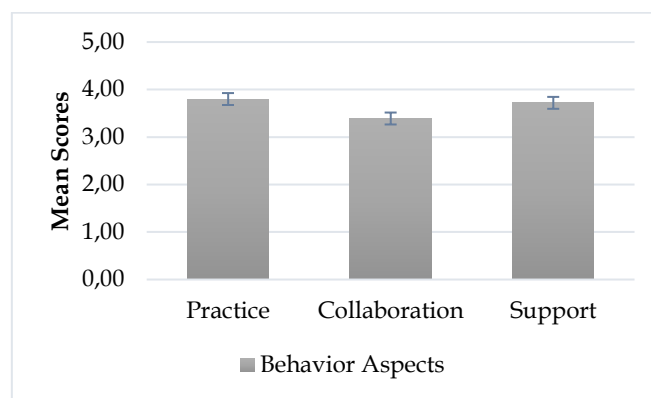conservation. The results of measuring the behavior aspects are presented in Figure 4.

Figure 4. Results of measurement of student behavior aspects

Based on the measurement results, the practical aspect is the highest indicator with an average of 3.8. The practical indicator in question is student awareness in sorting and managing chemical waste according to procedures by implementing environmentally friendly laboratory practices and using alternative chemicals that are safer for the environment. According to Nainggolan et al. (2023), socialization and increasing participation in waste management through education and direct involvement can increase public awareness of environmental cleanliness and expand the reach of information to new residents through print and electronic media. This is in line with research by Wang et al. (2021) which states that a green chemistry-based educational approach significantly increases environmental awareness and reduces the negative impacts of chemical waste through the use of more sustainable methods. The implementation of environmentally friendly practices in laboratory activities and ongoing education are important keys in shaping the collaborative character of prospective chemistry teachers towards environmental sustainability.

The data also shows an average collaboration indicator of 3.4. This collaboration indicator is related to actively participating in chemistry-based environmental projects with friends or lecturers, discussing innovative solutions for laboratory waste management with colleagues, and being involved in environmental education programs to increase student awareness. The supporting factors for community pro-environmental behavior are cognitive factors in the form of community knowledge (Maulidiana et al., 2023). With a moderate category, this is likely due to the lack of opportunities available for prospective chemistry teacher students to actively collaborate in environmental projects, both on and off campus. In addition, time constraints, minimal

support from institutions, and the lack of integration of environmental issues in the curriculum can also be inhibiting factors in building sustainable and meaningful collaboration. As the results of a study by Ekaputra (2023) stated that one of the main causes is the tendency of students to divide tasks individually in practical activities, which reduces interaction and cooperation between group members. In addition, the lack of integration of environmental aspects in chemistry practicums and the lack of environmentally friendly resources are also obstacles (Djangi et al., 2024). In addition, Akinsipo et al. (2025) highlighted that limited funds, resources, and awareness are major challenges in implementing environmental education principles in higher education, which also influences low collaboration in environmental activities. Thus, a strategy is needed that can encourage the creation of a more intensive and sustainable collaborative space, either through the provision of environmental-based projects on campus, strengthening the role of lecturers in facilitating teamwork, or integrating environmental issues into practical activities to foster awareness and shared responsibility for environmental conservation.

Environmental Awareness Level of Prospective Chemistry Teacher

Overall, based on the aspects of knowledge, attitude and behavior, it shows that prospective chemistry teacher students still need follow-up related to environmental awareness. The results of environmental awareness measurements can be seen in Figure 5.
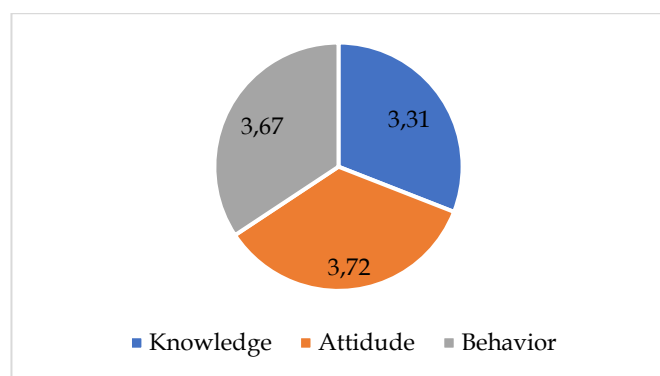

Figure 5. Results of student environmental awareness measurement

Based on the data in Figure 5, it can be seen that students' environmental awareness is in the moderate category in the knowledge aspect and in the high category in the attitude and action aspect. This is indicated by the average student knowledge of 3.31 in the interval of 2.61-3.40 which is included in the moderate category. In the attitude aspect, it shows an average of 3.72 in the interval of 3.41-4.20 which is included in the high category. Likewise, in the behavior aspect, it shows an average of 3.67 in the interval of 3.41-4.20 which is included in the high category. There is a positive relation btween knowledge and attitudes, knowledge with environmental behavior and attitudes with student evironmental behavior (Fetiana et al., 2022). The low knowledge score compared to the attitude and behavior aspects (although still in the moderate category) indicates that prospective chemistry teacher students have limited understanding of environmental issues. Some possible causes are that students receive information that is not in-depth and general in nature, are not used to reading books, journals, or scientific articles on the environment and the lack of environmental discussions or studies in lectures. This causes students not to fully understand environmental issues or scientific solutions to overcome them. Research by Cvetković et al. (2024) show that differences in educational systems and socio-economic factors can influence the level of environmental awareness and knowledge among students, which has an impact on their environmental behavior.

High scores on the attitude aspect indicate that students have concern and positive emotional responses to environmental issues. Although their knowledge is not yet in-depth, students still show strong personal values and commitment to environmental conservation. Their awareness is further reflected in the beliefs, values, and judgments expressed in their reflective journals, such as the development of environmental literacy, a shift toward pro-environmental behaviors, and a positive commitment to environmental protection (Setiawan et al., 2023). This attitude can be formed from social influences, media, or personal experiences, not solely from formal education.

High scores on the behavior aspect indicate that students have implemented environmentally friendly behavior, such as; disposing of garbage in its place, saving water or electricity and reducing the use of plastic. This shows that real behavior can occur even though knowledge is not optimal. This confirms that a strong attitude can encourage positive behavior even though it is not fully understood theoretically. Research by Syafitri et al. (2024) shows that although most students have a good caring attitude, their level of knowledge still varies, indicating the need to increase knowledge to support attitudes that are already positive. This phenomenon is also supported by research by Colombo et al. (2023), who observed the possibility of someone being more consistent in implementing environmental awareness behavior even though their knowledge is limited. Hendriana et al. (2025) show that there is an influence of Pro-Environmental Behavior on student character. A multidimensional assessment

framework involving cognitive and behavioral constructs has also been employed in recent chemistry education studies. For example, Ridho et al. (2025) utilized knowledge, understanding, attitude, and application dimensions to evaluate students' conceptual and behavioral responses in a general chemistry context, demonstrating the relevance of multi-construct instruments in educational measurement. Thus, it is important for educational institutions to not only improve students' environmental knowledge but also develop psychological skills such as self-awareness to strengthen the consistency between environmental awareness attitudes and behaviors.

Conclusion

The findings indicate that prospective chemistry teachers exhibit high levels of environmental attitudes and behaviors, while their knowledge remains at a moderate level. This imbalance suggests the need to strengthen the cognitive foundation of environmental education through structured learning, integration of environmental issues across courses, and increased engagement with scientific literature. The implications of this study highlight the importance of collaborative programs involving institutions, lecturers, and communities to cultivate stronger environmental literacy. This study has limitations related to its single-institution sample and descriptive design, which restrict the generalizability of results. Future research should consider experimental or longitudinal approaches to evaluate the effectiveness of instructional interventions, expand samples across universities, and investigate factors influencing the development of environmental awareness in teacher education.

Author Contributions
Conceptualization, D.R. and W.B.; Methodology, D.R. and W.B.; Data Collection, D.R. and E.L.B.; Formal Analysis, D.R. and E.L.B.; Writing—Original Draft Preparation, D.R. and E.L.B.; Writing—Review and Editing, W.B.; Supervision, W.B.

Conflicts of Interest
No conflicts of interest.

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