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The moderating role of conservation education in the effect of climate change awareness and pro-environmental behavior on students' sustainable lifestyle

Anis Susanti[1], Aulia Prima Kharismaputra[2], Dian Fithra Permana[3], Dewi Azizatul Kholqiyah[4]

[1]*Faculty of Economics and Business, Universitas Negeri Semarang, Indonesia, Corresponding author, anissusanti@mail.unnes.ac.id, ORCID ID: 0009-0008-6613-8105*
[2]*Faculty of Economics and Business, Universitas Negeri Semarang, Indonesia, ORCID ID: 0009-0004-0031-5341*
[3]*Faculty of Economics and Business, Universitas Negeri Semarang, Indonesia, ORCID ID: 0000-0002-2912-8855*
[4]*Faculty of Economics and Business, Universitas Negeri Semarang, Indonesia, ORCID ID: 0009-0005-1983-435X*

ABSTRACT
This study examines the role of conservation education in moderating the relationship between pro-environmental behavior and sustainable lifestyles among students at Semarang State University, Indonesia. The findings indicate that conservation education does not significantly moderate this relationship, suggesting that while students develop pro-environmental behavior, it does not necessarily lead to a sustainable lifestyle. The R-Square test results show that the model explains 45.7% of the variance in sustainable lifestyles, while external factors influence 54.3%. Discriminant validity analysis confirms that the constructs used meet the necessary validity criteria. Several factors may contribute to the limited moderating effect of conservation education, including curriculum limitations, insufficient behavioral interventions, and students' pre-existing environmental attitudes. While environmental education increases knowledge about sustainability, it does not automatically translate into behavioral change. To enhance its effectiveness, conservation education should incorporate experiential learning, hands-on activities, and social reinforcement mechanisms. Universities can implement service-learning projects, eco-campus initiatives, and internships with environmental organizations to bridge the gap between knowledge and action. This study highlights the need for a multi-dimensional approach to sustainability education. Future research should explore longitudinal studies to assess long-term behavioral changes and examine additional institutional and social factors that influence sustainable lifestyles. These findings contribute to the ongoing discourse on sustainability education by emphasizing the importance of integrating theoretical knowledge with practical applications to foster meaningful environmental behavior change.

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Introduction

Semarang State University is recognized as a conservation-oriented university that integrates environmental values into its academic and community activities. It plays an important role in preparing students to develop strong environmental knowledge and awareness so that, after graduation, they can apply conservation principles such as protection, preservation, and the sustainable use of natural resources, human resources, the environment, arts, and culture in their daily lives and professions. The existence of conservation-based character education at Semarang State University is expected to produce people who can develop themselves, their communities, and their country sustainably. A person's character is formed indirectly through the learning and education they undergo, rather than something they are born with, through the shaping of their environment and the influence of the people around them (Tang et al., 2023). In general, the character of conservation is reflected in concrete human actions, as 'conservation' itself is a social construct that can be observed in the sustainable management and use of natural resources for the benefit of present and future generations. The conservation-based values developed at Semarang State University encompass 11 core principles: honesty, religiosity, intelligence, justice, responsibility, tolerance, care for others, democracy, patriotism, politeness, and resilience (Wibowo et al., 2017). These values explain Semarang State University's vision: "University with a World Reputation and Pioneer of Excellence in Education with a Conservation Insight". The character values to be developed by students in each faculty include honesty, fairness, inspiration, respect for human dignity, compassion, innovation, creativity, and teamwork. Through this character development, it is hoped that students can make a real contribution to the development of a dignified national identity amidst the challenges of the global world. The primary means of implementing conservation character education is through the general course Conservation Education.

Conservation education aims to increase people's knowledge, skills, and awareness of environmental values and issues, thereby fostering positive changes in attitudes and behavior. Conservation education is a learning process to change the mindset from using natural resources for the benefit of the present without thinking about the future of future generations, to using natural resources wisely for the sake of the sustainability of environmental functions and the sustainability of the future for the next generation (Huda & Feriandi, 2018). Through the conservation education process, it is hoped that students, as members of society, will develop awareness and sensitivity towards the environment. There are 3 important aspects of conservation education learning: cognitive, affective, and psychomotor. The cognitive aspect involves understanding the scientific principles that govern ecosystem functions and the strategies required to sustain environmental equilibrium. Affective aspects that can be applied in conservation education include the values, attitudes, and commitment needed to build a sustainable society. The psychomotor aspect of conservation education concerns students' behavior and skills for managing the surrounding environment. Through conservation education, students are expected to be able to solve problems in their surrounding environment, both the physical and social environments (Wibowo et al., 2017). The focus of conservation education is to develop communities that can understand, appreciate, and implement sustainable, pro-environmental behavior (Potter, 2009).

While prior studies confirm the direct relationship between environmental awareness and pro-environmental behavior (Cardenas Morales et al., 2025; Mkumbachi et al., 2020), few examine structured conservation education programs as a moderating variable. Existing research has primarily focused on environmental education, which emphasizes developing knowledge and skills related to environmental issues, and moral education, which seeks to cultivate values and ethical reasoning that guide pro-environmental behavior (Begum et al., 2021). However, these approaches are often treated separately and lack specificity regarding how formal conservation-centric curricula can amplify the impact of climate change awareness and behavior on sustainable lifestyles.

Current literature highlights short-term behavioral outcomes (e.g., recycling, energy conservation) but rarely explores how conservation education fosters enduring sustainable

lifestyles (Piao & Managi, 2023). There is a gap in understanding the pedagogical strategies (e.g., experiential learning, community projects) that translate awareness into lifelong habits.

According to the Theory of Planned Behavior, various factors contribute to behavioral change, both directly and indirectly. Attitudes, subjective norms, and perceived behavioral control are interconnected elements that indirectly shape an individual's behavior. These three factors directly influence a person's intention to change, which, in turn, leads to actual behavioral change. Attitude reflects an individual's positive or negative evaluation of a particular behavior. Meanwhile, subjective norms refer to the social pressure one experiences regarding whether to engage in or refrain from a specific action or behavior (Ajzen, 1991).

This study aims to examine the mediating role of conservation education in the relationship between climate change awareness, pro-environmental behavior, and students' sustainable lifestyles. Specifically, it investigates how conservation education not only enhances students' environmental awareness but also strengthens their perceived behavioral control and collective responsibility, ultimately fostering long-term sustainable practices.

The community-oriented nature of conservation education suggests that its impact extends beyond individual knowledge acquisition to the cultivation of shared responsibility and sustained behavioral change. This aligns with the Theory of Planned Behavior, which posits that subjective norms and perceived behavioral control influence individuals' intentions and actions. Within this framework, conservation education may serve as a crucial mechanism for translating environmental awareness into tangible, sustainable behavior. The problem formulation that can be drawn from the research background is as follows: (1) does climate change awareness affect students' sustainable lifestyle?; (2) does pro-environmental behavior influence students' sustainable lifestyle; (3) does conservation education play a mediating role in the influence of climate change awareness on students' sustainable lifestyles; (4) does conservation education play a mediating role in the influence of pro-environmental behavior on students' sustainable lifestyle; (5) Does climate change awareness and pro-environmental behavior influence students' sustainable lifestyle through conservation education?

Climate change is a pressing issue that significantly impacts the younger generation (Jürkenbeck, Spiller, and Schulze 2021). Students must be aware of their level of climate change awareness. Social media campaigns have played a key role in educating the public and raising awareness about climate change in Indonesia, leading to lifestyle changes among its people (Turpyn & Adwitiya, 2021). Understanding the extent of public awareness regarding climate change is essential for formulating appropriate policies to mitigate its risks, especially in highly vulnerable countries such as Indonesia (Nggole, Tyas, and Pradoto 2019). However, studies indicate that Indonesians generally have low awareness and concern about climate change issues (Lee et al., 2015). On the other hand, social media has proven to be an effective tool in educating Generation Z and increasing their awareness of climate change challenges (Ariestya, Paramitha, and Elmada 2022).

The existing literature shows that environmental education plays an important role in shaping students' environmental attitudes and behaviors. Specifically, research has shown that environmental education can help students integrate environmental concerns into their future professional contexts, ensuring the continuation of sustainability efforts long after graduation. Additionally, students' pro-environmental willingness was significantly correlated with their participation in environmental associations and their academic majors, highlighting the importance of integrating environmental education across all disciplines. While studies link environmental education to pro-environmental behaviors, the specific moderating role of conservation education remains underexplored (Piao & Managi, 2023). Research often broadly defines environmental education, neglecting conservation education's unique focus on resource protection and direct engagement (Prayogo et al., 2022). Furthermore, contextual factors, long-term lifestyle changes, and moderating capacity are often overlooked. The influence of subjective norms and perceived behavioral control is also frequently omitted; conservation education's impact likely hinges on perceived community support and individual capabilities (Xu et al., 2022). Existing literature thus inadequately elucidates conservation education's distinct role in fostering sustainable lifestyles, leaving a crucial gap to be addressed.

Human behavior plays a significant role in shaping environmental quality, and as future leaders, students hold a crucial responsibility in environmental conservation (Shafiei & Maleksaeidi, 2020). Pro-environmental behavior reflects an individual's awareness and commitment to minimizing negative environmental impacts through daily activities (Dono, Webb, and Richardson 2010). However, students' engagement in environmental concerns still requires attention. Previous studies have found that students in Indonesia generally exhibit a moderate level of pro-environmental behavior (Dewi, 2018). Universities, as students' second home, have a vital role in fostering sustainable environments (Siregar et al., 2022). Research also suggests that Indonesians still display relatively low levels of pro-environmental behavior in their daily routines (Djuwita & Benyamin, 2019).

To mitigate climate change, adopting a sustainable lifestyle is essential. This involves engaging in environmentally friendly practices across various aspects of life, including energy consumption at home, mobility, food consumption, and product usage. However, studies reveal that individuals do not always consistently apply pro-environmental behaviors across these different domains (Dreijerink, Handgraaf, and Antonides 2022). Encouraging sustainable lifestyles within communities requires a focus on behavioral patterns and ingrained habits.

Previous research has demonstrated that conservation education significantly enhances knowledge and attitudes toward environmental protection, effectively strengthening the link between awareness and pro-environmental behavior (Ma et al., 2023). Other studies have highlighted the role of environmental education in bridging environmental knowledge and pro-environmental intentions, emphasising its importance in fostering sustainable behaviors (Ozbey et al., 2024). At Semarang State University, conservation education is integrated into the curriculum as a general subject, aligning with the university's vision to help students adopt sustainable lifestyles. Furthermore, this initiative contributes to broader public education efforts, promoting economic development and cooperative human behavior to safeguard environmental sustainability (Piao & Managi, 2023).

Methods

This study employs a quantitative research approach, focusing on collecting numerical data and using statistical techniques to examine relationships among variables and test the proposed hypotheses. Specifically, this study employs a descriptive research method, which aims to present an accurate and systematic depiction of the phenomenon under investigation based on collected data. This approach is valuable for identifying patterns, characteristics, and relationships that can inform subsequent analysis and interpretation (Sugiyono, 2020). This study adopts a descriptive–confirmatory design: it first provides a systematic overview of the variables under study and then tests specific hypotheses to examine their relationships. To achieve this, the study applies Partial Least Squares Structural Equation Modeling (PLS-SEM), a method well-suited for exploratory research and predictive modeling (Hair & Alamer, 2022).

Data Collection

Data for this study were obtained through a structured questionnaire designed to assess participants' perceptions, attitudes, and self-reported behaviors. It is acknowledged, however, that self-reported measures may not fully reflect actual behavior due to potential biases such as social desirability and respondents' awareness of expected answers. It was distributed to students at Semarang State University enrolled in conservation education courses. The population in this study was Semarang State University students who had completed Conservation Education courses. Conservation Education is a compulsory course designed to instill the values of environmental sustainability and local wisdom, in line with the university's identity as a Conservation University. The course is typically offered in the second semester of undergraduate programs across all faculties. The course carries 2 credit units (2 credits) and runs for approximately 16 weeks within a regular semester. Each week consists of 100 minutes of lectures, discussions, and project-based activities. The average class size is up to 200

students, depending on the study program and student intake in each academic year. The material is delivered using a combination of lectures, group discussions, case studies, field observations, and project-based learning (PjBL). This approach allows students not only to understand the theoretical concepts of conservation but also to engage directly with environmental issues in their surroundings.

To mitigate potential bias in data collection, several measures were implemented. First, a stratified sampling technique (Howell et al., 2020) was used to ensure representation across different faculties and academic levels, reducing the risk of overrepresentation from any particular group. Second, response bias was minimized by ensuring anonymity and confidentiality, and by encouraging students to provide honest answers without fear of judgment. The questionnaire was carefully designed to use neutral and clear language, avoiding leading questions that might influence responses. To further control for social desirability bias, participants were reminded that there were no right or wrong answers, and the study aimed to understand their genuine perceptions and behaviors. The sample used in SEM (Structural Equation Modeling) research is 100-200 (Hair et al., 2014). In this study, 300 respondents were included.

The questionnaire consisted of multiple sections measuring climate change awareness, pro-environmental behavior, conservation education, and sustainable lifestyles using a five-point Likert scale. To ensure validity and reliability, the instrument was tested with a small sample (30) before full-scale distribution. The questionnaire was administered online using Google Forms to maximize response rates while maintaining data accuracy. A stratified sampling technique was used to ensure representation across different faculties and academic levels. Ethical considerations, including informed consent and confidentiality, were strictly maintained. The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine direct, indirect, and mediating effects within the proposed research model.

To measure respondents' perceptions, this study uses a Likert scale with five response categories, as presented in Table 1.

Tabel 1

Likert scale

Answer	Category	Score
Strongly Agree	Very High	5
Agree	High	4
Neutral / No Opinion	Moderate	3
More Disagree	Low	2
Strongly Disagree	Very Low	1

The research instrument was administered in Bahasa Indonesia to ensure respondents' full comprehension. The origiThe final questionnaire was developed in English and then translated into Bahasa Indonesia by a bilingual expert. A second independent translator conducted a back-translation to verify conceptual and linguistic equivalence. Any discrepancies were resolved through discussion to maintain the instrument's validity and reliability.

Climate Change Awareness

1. Climate change is the impact of the thinning of the ozone layer
2. Greenhouse gas emissions cause climate change
3. Every individual can do a lot to reduce climate change
4. Human activity is the main cause of climate change
5. Climate change is the main obstacle to efforts to sustain economic growth
6. I feel worried about consumption behavior and the environment
7. I feel embarrassed when I find that around me, no one cares about the environment

Pro-Environmental Behavior

1. I always aim to save food, water, and energy wherever I can

2. I always intend to save as many natural resources as I can
3. I always intend to choose to travel as environmentally friendly as possible
4. I always intend to sort waste and recycle as much waste as possible
5. I always intend to buy environmentally friendly products
6. I would like to spend more money on environmentally friendly products than conventional products
7. If I have the opportunity to take part in an environmentally oriented organization, I will always be ready to be an active member

Sustainable Lifestyle

1. I avoid using disposable tissue paper when in the toilet
2. I eat food without plastic packaging
3. I clean the kitchen with a cloth rather than paper towels
4. I avoid using disposable plates, spoons, forks, straws, and glasses when eating/drinking
5. I save energy by implementing energy-saving practices (turning off lights when not in use, using natural light all day, turning off the AC, and turning off the computer when not in use)
6. I turn off the tap water when brushing my teeth, soaping my body, and washing my clothes
7. I buy local and domestic products
8. I try to use biodegradable products in my daily life
9. I avoid using plastic bags for shopping
10. I avoid buying too many clothes
11. I avoid leaving food out

Conservation Education

1. I took part in reforestation activities around campus to maintain biodiversity as an assignment for a conservation education course
2. I have attended outdoor conservation education lectures
3. I have visited a place where compost or recycled products are made as a form of conservation education lecture
4. Lecture materials are linked to conservation values, namely inspirational, humanistic, caring, innovative, creative, sportsmanlike, honest, and fair
5. Conservation education lectures make me behave cleanly and healthily, in the sense of showing great concern for myself, the social environment, and the physical environment in the classroom and outside the classroom

It is acknowledged that self-reported questionnaires may not always reflect actual behaviors, as respondents may provide socially desirable answers rather than accurate accounts of their actions. This is particularly relevant for constructs such as pro-environmental behavior and conservation participation, where individuals might overstate their engagement to align with expected norms. To mitigate this limitation, the questionnaire items were designed to be specific and behavior-focused, reducing the likelihood of vague or inflated responses. Additionally, this limitation is recognized and accounted for in the interpretation of results. Although the listed conservation education activities can be completed in a short amount of time, the focus of this study is to capture students' reported exposure to conservation-related learning experiences rather than to measure the depth or intensity of their engagement. Therefore, the findings should be interpreted as indicative of participation frequency or presence, not necessarily the quality or impact of participation. Future research may complement this approach with observational or qualitative methods to gain deeper insights.

Based on the results of validity and reliability testing using Partial Least Squares Structural Equation Modeling (PLS-SEM), all measurement items in this study meet the required criteria. The outer loading values for each indicator exceeded the recommended threshold of 0.70, indicating good indicator validity. Furthermore, the values of Average Variance Extracted (AVE) for each construct were above 0.50, confirming convergent validity. Additionally, the Composite Reliability

(CR) and Cronbach's Alpha values for each latent variable were above 0.70, ensuring that the instruments have high internal consistency reliability. Discriminant validity was also achieved based on the Fornell-Larcker criterion and cross-loading analysis, confirming that each construct is distinct from the others. Therefore, it can be concluded that all instruments used in this study are valid and reliable for measuring the constructs of Climate Change Awareness, Pro-Environmental Behavior, Sustainable Lifestyle, and Conservation Education in the context of PLS-SEM analysis.

Data Analysis

Data analysis in this research uses Partial Least Squares (PLS). PLS is a component or variant-based Structural Equation Modeling (SEM) model. PLS is an alternative to covariance-based SEM that shifts to a variance-based SEM. Covariance-based SEM generally tests causal hypotheses or theories, while PLS is more of a predictive model. PLS is a powerful analysis method because it is not based on many assumptions. The purpose of using PLS is to help researchers for prediction purposes (Putu Gede Subhaktiyasa, 2024). The formal model conceptualizes a latent variable as a linear combination of its observed indicators. The weight estimates used to construct latent variable scores are derived from the specification of both the inner model, or the structural relationships among latent variables, and the outer model, or the measurement relationships between indicators and their corresponding constructs (Hair et al., 2017). Conservation education as a structured intervention remains an emerging area, requiring a method that allows for theory development while handling complex relationships. Unlike covariance-based SEM, which focuses on model fit, PLS-SEM prioritizes predictive accuracy, making it ideal for understanding how climate change awareness and pro-environmental behavior influence students' sustainable lifestyles through conservation education. Additionally, this study involves multiple mediation effects, which PLS-SEM effectively estimates. Given that survey data in educational research often deviates from normality, PLS-SEM is more robust as it does not require strict normality assumptions and performs well with moderate sample sizes. Furthermore, because the moderating role of conservation education is underexplored, PLS-SEM enables a flexible approach to examining indirect effects and refining theoretical frameworks. Thus, PLS-SEM is the most appropriate method for this study to generate meaningful insights.

Findings

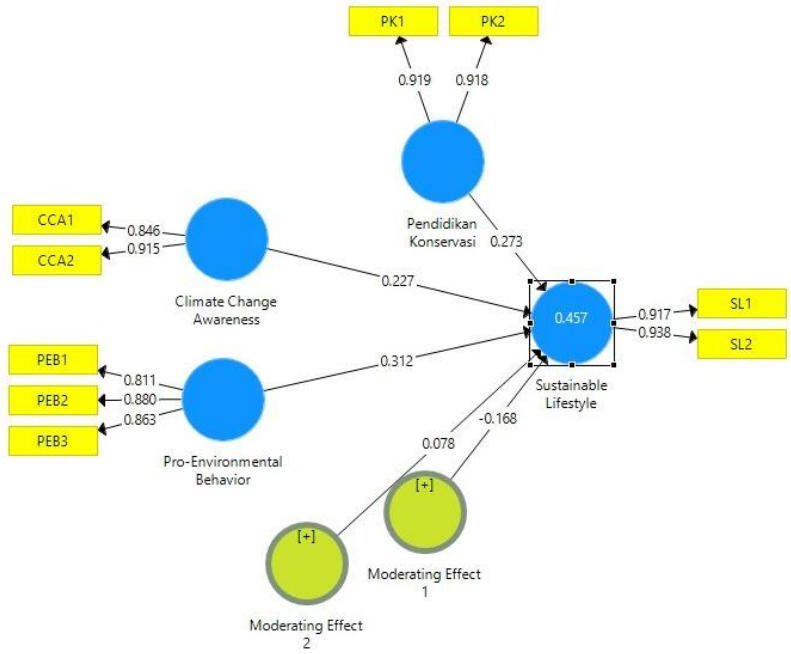
Figure 1 illustrates the structural model used in this study to examine the relationships between climate change awareness, pro-environmental behavior, conservation education, and sustainable lifestyle. The arrows represent hypothesized causal paths, with the corresponding coefficients indicating the strength of each relationship. Conservation education is positioned as a mediating variable, linking climate change awareness and pro-environmental behavior to sustainable lifestyle outcomes. The model also incorporates moderating effects to capture potential interaction influences among variables.

Partial Least Squares (PLS) Model

Hypothesis testing used Smart PLS version 3 program. Research data obtained from respondents were analyzed using SmartPLS with the Outer Model to assess construct validity and reliability. The following are the test results of the Outer Model tested:

Figure 1

Outer model



Outer Model Evaluation

The evaluation of a measurement model involves analyzing the relationship between construct variables (indicators) and their corresponding latent variables. The primary objective of this evaluation is to verify the model's validity and reliability through appropriate testing. This process ensures that the measurement instruments used provide accurate and consistent data. In this study, Structural Equation Modeling (SEM) was applied using the SEM-PLS analytical tool. Validity is assessed through two key tests: Convergent Validity and Discriminant Validity. Meanwhile, reliability is evaluated using the Composite Reliability test and Cronbach's Alpha coefficient.

According to Ghozali and Latan (2015:74), an indicator is considered to have good validity if its Outer Loading is above 0.70. The higher the value of a factor loading, the higher the role of the loading in interpreting the factor matrix. Convergent validity of a construct and its indicators can be assessed using the Average Variance Extracted (AVE), which should exceed 0.5. Apart from that, Ghozali and Latan (2015:75) stated that an AVE value of 0.50 or more indicates that the construct can explain 50% or more of the item variance. Thus, the rule of thumb for assessing convergent validity is a Loading Factor > 0.70 and an Average Variance Extracted (AVE)> 0.50. In this research, the convergent validity test is evaluated through the Outer Loading value, which is measured as follows:

Table 2

Outer loading of indicators on research variables

Variable	Indicator	Outer Loading	Taraf *Convergent Validity*	Description
Sustainable Lifestyle (Y)	SL1	0.917	0.7	Valid
	SL2	0.938	0.7	Valid
Climate Change Awareness (X1)	CCA1	0.846	0.7	Valid
	CCA2	0.915	0.7	Valid
Pro-environmental Behavior (X2)	PEB1	0.811	0.7	Valid
	PEB2	0.880	0.7	Valid

	PEB3	0.863	0.7	Valid
Conservation Education (M)	PK1	0.919	0.7	Valid
	PK2	0.918	0.7	Valid

The table above shows that the outer loading for each variable, such as sustainable lifestyle, climate change awareness, pro-environmental behavior, and conservation education, is greater than 0.7, so it can be categorised as high. These results illustrate that the indicaThe search constructs are valid and meet the requirements for convergent validity, so they can be used to measure the research variables. The next evaluation step towards convergent validity is carried out by analyzing the Average Variance Extracted (AVE) value for each variable as follows:

Table 3

Average Variance Extracted (AVE) value for each research variable

Variables	AVE Value	AVE Sig	Description
Sustainable Lifestyle (Y)	0.861	0.5	Valid
Climate Change Awareness (X1)	0.776	0.5	Valid
Pro-environmental Behavior (X2	0.726	0.5	Valid
Conservation Education (M)	0.844	0.5	Valid

The table above shows that the AVE value for each variable is > 0.5. This means that each research variable meets the rule-of-thumb criterion of AVE > 0.5, indicating that each variable is a good research construct.

The discriminant validity test aims to determine whether a reflective indicator is truly a good measure of its construct based on the principle that each indicator must be highly correlated with its construct. According to Ghozali and Latan (2015:74), the cross-loading value for each variable must be > 0.70; it is hoped that the correlation of the construct with the measurement items is greater than that of other constructs.

The second measurement is the square root of the AVE in the Fornell-Lacker Criterion. According to Fornell and Larcker (cited in Ghozali and Latan, 2015: 75), a model has good discriminant validity if each construct's AVE is greater than the correlation with other constructs. The following are the results of the Cross Loading indicators for each research variable, which can be seen in the table:

Table 4

Cross-loading results for each research variable

Indicator	Variables				Results
	CCA	PEB	SL	PK	
CCA1	0.846	0.467	0.385	0.251	Valid
CCA2	0.916	0.646	0.509	0.297	Valid
PEB1	0.566	0.811	0.467	0.363	Valid
PEB2	0.542	0.880	0.519	0.492	Valid
PEB3	0.538	0.863	0.531	0.453	Valid
SL1	0.487	0.499	0.917	0.397	Valid
SL2	0.470	0.598	0.938	0.523	Valid
PK1	0.327	0.497	0.461	0.919	Valid
PK2	0.247	0.448	0.458	0.918	Valid

The table above shows that the correlation values for each construct with its measurement items are greater than those for other constructs. For example, the correlation between the CCA1 indicator and the CCA latent variable (0.846) is greater than the correlations of the CCA1 indicator with the latent variables in the other blocks (0.467, 0.385, and 0.251). Thus, the indicator is declared valid.

The second measurement is the square root value of AVE. Below, the square root value of AVE for each research variable can be seen in the table:

Table 5

AVE square root value on the Fornell-Larcker criterion

Variables	Variable Square Root Value				Results
	CCA	PK	PEB	SL	
Climate Change Awareness	**0,881**				Valid
Conservation Education	0.313	**0,919**			Valid
Pro-environmental Behavior	0,643	0,514	**0,852**		Valid
Sustainable Lifestyle	0,515	0,500	0,594	**0.928**	Valid

The table shows that the square root of the AVE for each construct is greater than the correlation between that construct and the other constructs in the model. For example, the square root of the AVE for the CCA variable is 0.881; this value is greater than the correlations of the construct with other constructs (0.313, 0.643, 0.515). This means that all constructs in the estimated model have satisfied the rule-of-thumb criterion for discriminant validity.

In addition to being assessed using Convergent Validity and Discriminant Validity, the Outer Model can be evaluated by examining the reliability of the construct or latent variable, as indicated by Cronbach's Alpha and Composite Reliability. The construct is considered reliable if Cronbach's Alpha and Composite Reliability are both> 0.70 (Ghozali & Latan, 2015, p. 77). The following are the Cronbach's Alpha results for each research variable, which can be seen in the following table:

Table 6

Cronbach's alpha

Variable	*Cronbach's Alpha*	*Sig Cronbach's Alpha*	Results
Sustainable Lifestyle	0,839	0,7	Reliable
Climate Change Awareness	0,716	0,7	Reliable
Pro-environmental Behavior	0,811	0,7	Reliable
Conservation Education	0,815	0,7	Reliable

The table above indicates that the Cronbach's Alpha value for each variable construct is greater than 0.70. This confirms that all variables are reliable and suitable for use in research. Furthermore, the results can also be examined through Composite Reliability, as shown below:

Table 7

Composite reliability of research variables

Variable	Composite Reliability	Sig Composite Reliability	Results
Sustainable Lifestyle	0,925	0,7	Reliable
Climate Change Awareness	0,874	0,7	Reliable
Pro-environmental Behavior	0,888	0,7	Reliable
Conservation Education	0,915	0,7	Reliable

Based on the table above, it shows that Composite Reliability for each variable is declared a construct, so that each construct can be positioned as a research variable. It can be concluded that all variables exhibit adequate consistency in measuring the latent variables/constructs in a composite manner, allowing them to be used for subsequent analysis. This study iIt incorporates both the Outer Model (Measurement Model) and the Inner Model (Structural Model) in its research framework. The distinction between these two models is crucial, as each serves a specific purpose in validating the study's findings.

Ensuring the validity of both the Outer Model (Measurement Model) and the Inner Model (Structural Model) is essential for obtaining reliable and meaningful research findings. The outer model plays a crucial role in confirming that the measurement of key variables—climate change awareness,

pro-environmental behavior, sustainable lifestyle, and conservation education—is accurate and consistent. Without a validated outer model, the indicators used to measure these constructs may not accurately reflect the intended concepts, leading to unreliable results. Meanwhile, the inner model is necessary to examine and interpret the relationships among these variables, enabling hypothesis testing and a deeper understanding of how climate change awareness influences pro-environmental behavior and sustainable lifestyles, with conservation education as a moderating factor. By integrating both models, this study ensures a scientifically rigorous analysis that strengthens the reliability of the findings. This approach provides valuable insights into the role of conservation education in enhancing students' environmental awareness and promoting sustainable behaviors, ultimately contributing to a greater understanding of how education can shape environmentally responsible lifestyles.

The following is the Structural Model scheme, or Inner Model scheme, used in this research, which employs Smart PLS 3.

Figure 2

Inner model

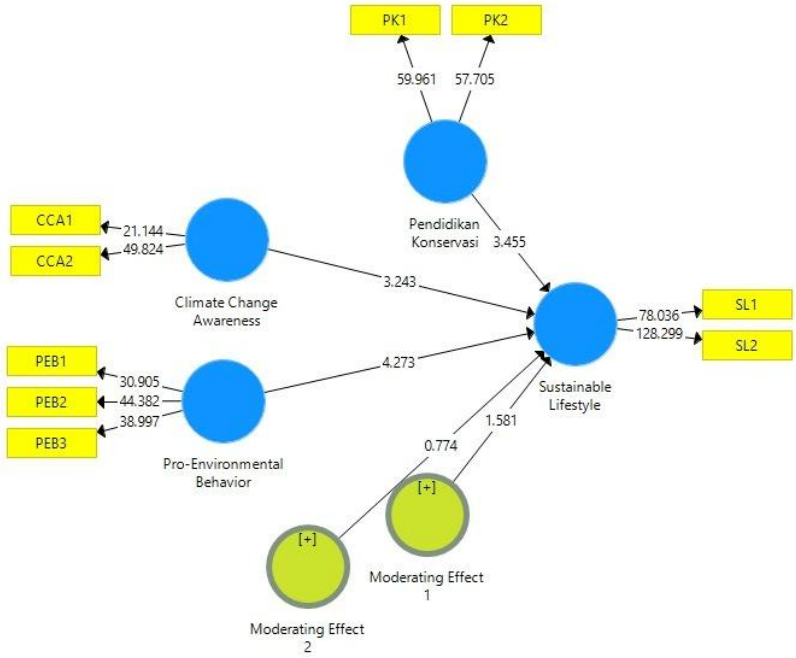


Figure 2 presents the inner model, which illustrates the structural relationships among the key latent variables examined in this study. Climate change awareness and pro-environmental behavior are hypothesized to directly influence sustainable lifestyle, while conservation education serves as a mediating variable that strengthens these relationships. The numbers on the paths represent the estimated coefficients, indicating the magnitude of the effect between constructs. Moderating effects are also included to capture potential interactions with the dependent variable.

The Structural Model, or Inner Model, is used to examine the influence of constructs. The inner model test was analyzed using R-Square, Q-Square, and statistical significance tests. The R-Square test is used to measure the level of variation in changes in exogenous variables towards endogenous variables. According to Ghozali and Latan (2015: 81), if R-Square > 0.67, the model is strong or good; if 0.68 > R-Square> 0.33, the model is fair or moderate; and if R-Square> 0.19, the model is weak. The following R Square (R2) results can be seen in the table:

Table 7

R-square test results (R2)

Variable	R-*Square*	*Adjusted R-Square*	Result
Sustainable Lifestyle	0,457	0,446	Moderates

Conservation education, climate change awareness, and pro-environmental behavior collectively explain 45.7% of the variance in sustainable lifestyle, while other unobserved factors influence the remaining 54.3%. This aligns with prior studies examining behavioral intentions and sustainability-related behavior, in which R^2 values often range from 0.30 to 0.50 in complex psychological and educational models (Ravand & Baghaei, 2016). The moderate R^2 value suggests that while the selected variables contribute significantly to sustainable lifestyle outcomes, additional factors—such as social norms, institutional policies, and personal motivations—may further explain students' engagement in sustainability practices.

A research model is considered good if the Q-Square is greater than zero. Meanwhile, if the Q-Square value is negative, the research model is not predictive. The following are the results of the Q-Square test on the sustainable lifestyle variable:

Q-Square Sustainable Lifestyle $= 1 – (1 - R1^2) (1 - R^2)$
$= 1 – (1 – 0,457) (1 – 0,446)$
$= 1 – (0,543) (0,554)$
$= 0,699$

Based on the calculation above, the Q-Square value for the sustainable lifestyle variable is 0.699. The figure shows > 0, indicating that the sustainable lifestyle research model has strong predictive relevance. The Q-Square value of 0.699 further reinforces the model's predictive strength, indicating that the inclusion of conservation education enhances its explanatory capacity. This is consistent with research highlighting that structured environmental education programs significantly shape long-term pro-environmental attitudes and behaviors (Burgos-Espinoza et al., 2024). However, despite the model's predictive relevance, future studies could incorporate longitudinal data to assess how sustained exposure to conservation education influences lifestyle changes over time. Additionally, integrating external moderators, such as socioeconomic background or institutional support, may refine the model's predictive accuracy. This would align with prior work emphasizing multi-dimensional influences on sustainability behaviors, ensuring a more holistic understanding of conservation education's role in shaping pro-environmental lifestyles.

The t-test was used to determine the significance and the coefficient of the structural path parameters between variables by examining the t-statistic. The stability of this estimate is evaluated if the t-statistic produced by the variable is > 1.65 at the 10% significance level, 1.96 at the 5% significance level, and 2.58 at the 1% significance level obtained through bootstrapping calculations, Ghozali and Latan (2015:81). The following are the results of the t-statistical significance test:

Table 8

T-statistic significance test results

No.	Hypothesis	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	t-statistics	P-Values	Result
1.	CCA -> SL	0,227	0,244	0,073	3,113	0,002	Accepted
2.	PEB -> SL	0,312	0,323	0,074	4,244	0,000	Accepted
3.	PK -> SL	0,273	0,255	0,082	3,350	0,001	Accepted
4.	CCA -> PK -> SL	-0,168	-0,086	0,106	1,579	0,115	Rejected
5.	PEB -> PK -> SL	0,078	0,010	0,108	0,721	0,471	Rejected

Based on the data in the table above, this research examines the influence of climate change awareness and pro-environmental behavior on sustainable lifestyle as the dependent variable and tests the conservation education variable as a moderating variable, which determines whether the relationship is strengthened or weakened. The following is an explanation of the Path Coefficient results in the table above:

1) Climate change awareness has a positive and significant effect on sustainable lifestyle with a coefficient of t-statistics of 3.311 > 1.96 and a P-Value of 0.002 < 0.05.

2) Pro-environmental has a positive and significant effect on sustainable lifestyle with a coefficient of *t*-statistics of 4.244 > 1.96 and a P-Value of 0.000 < 0.05.

3) Conservation education has a positive and significant effect on sustainable lifestyle with a coefficient of t-statistics of 3.359 > 1.96 and a P-Value of 0.001 < 0.05.

4) Climate change awareness has a negative and insignificant effect on sustainable lifestyle through conservation education, with a coefficient of t-statistics of 1.579 < 1.96 and a P-Value of 0.115 < 0.05.

5) Pro-Environmental behavior has a negative and insignificant effect on sustainable lifestyle through conservation education, with a coefficient of t-statistics of 0.721 > 1.96 and a P-Value of 0.471 < 0.05.

Hypothesis testing in this research was carried out using a P-value < 0.05 at the 5% significance level. Based on Table 4.9, the P-value is 0.002 < 0.05, indicating significance at the 5% level. The original sample value is 0.227, indicating a positive influence of 22.7% on students' sustainable lifestyles from climate change awareness. The hypothesis (H1), which states that the climate change awareness variable has a positive and significant effect on sustainable lifestyles, is accepted. Based on Table 4.9, the P-value is 0.000 > 0.05, indicating that the pro-environmental behavior variable is accepted at the 5% significance level. As for the original sample value, it is 0.312, indicating a positive influence of 31.2% on students' sustainable lifestyle. The hypothesis (H2), which states that the pro-environmental behavior variable has a positive and significant effect on sustainable lifestyles, is accepted. Based on Table 4.9, the P-value is 0.001, which is greater than 0.05, indicating significance at the 5% level. The original sample value is 0.273, indicating a positive influence of 27.3% on students' sustainable lifestyles from conservation education. The hypothesis (H3), which states that the conservation education variable has a positive and significant effect on sustainable lifestyles, is accepted. Based on Table 4.9, the P-value is 0.115, which is greater than 0.05, indicating no significant difference at the 5% significance level. The original sample value is -0.168, indicating a negative influence of -16.8% and suggesting that climate change awareness does not significantly moderate its influence on students' sustainable lifestyles. The hypothesis (H4), which states that conservation education positively and significantly moderates the influence of climate change awareness on sustainable lifestyles, is rejected. This means that conservation education cannot moderate the influence of climate change awareness on students' sustainable lifestyles. These findings suggest that, within the scope of this study, students who take conservation education courses may not necessarily demonstrate a measurable change in their sustainable lifestyle associated with climate change awareness. However, the study does not provide direct evidence of behavioral change, and the results should therefore be interpreted with caution. Table 8 shows that the P-value is 0.471, which is greater than 0.05, indicating no significant difference at the 5% significance level. The original sample value is 0.078, indicating a negative influence of -7.8% and suggesting that it is not significant in moderating the effect of pro-environmental behavior on students' sustainable lifestyle. The hypothesis (H6), which states that conservation education positively and significantly moderates the influence of pro-environmental behavior on sustainable lifestyles, is rejected. This means that conservation education cannot moderate the influence of pro-environmental behavior on students' sustainable lifestyles at Semarang State University. These findings show that students who take conservation education courses do not improve their sustainable lifestyles, despite being influenced by pro-environmental behavior.

Discussion

One potential reason for the insignificant moderating effect of conservation education on the relationship between pro-environmental behavior and sustainable lifestyle could be limitations within the curriculum itself. If the course content focuses more on theoretical knowledge than on practical application, students may gain awareness but lack the behavioral reinforcement to integrate sustainability into their daily lives. Research suggests that effective conservation education requires active learning methods, such as hands-on projects and community-based initiatives, to translate environmental awareness into habitual action (Singh & Rahman, 2012).

Additionally, students' pre-existing pro-environmental attitudes could also contribute to the weak moderating effect. If students already have strong pro-environmental behaviors before taking the course, conservation education may not significantly enhance their sustainable lifestyle, as their attitudes and behaviors are already established. This aligns with Ajzen's Theory of Planned Behavior (Ajzen, 1991), which suggests that attitude formation precedes behavioral intention, meaning students with prior environmental awareness may not experience a noticeable shift through formal education alone.

Moreover, external factors, such as institutional support, social environment, and access to sustainable facilities, may also play a role in determining whether students can actively implement sustainability principles in their lives. Without structural support—such as campus-wide sustainability policies, recycling programs, or incentives for eco-friendly practices—students may find it difficult to incorporate sustainability beyond their academic setting (Uzorka et al., 2024). Future research could explore whether enhancing experiential learning, integrating sustainability-focused extracurricular activities, or institutional policy changes could strengthen the impact of conservation education in fostering a long-term sustainable lifestyle.

Awareness of climate change significantly influences sustainable lifestyles, although the relationship is complex and varies across demographics. Research shows that increased awareness can lead to behavioral changes, especially among younger generations, who are more likely to adopt climate-friendly diets (Jürkenbeck, Spiller, and Schulze 2021). University students represent an important social group within the younger population, though they do not constitute a generation in their own right. Increasing engineering students' understanding of and attitudes toward climate change is important for fostering awareness and encouraging them to integrate sustainability considerations into their future professional practice, rather than only their personal lifestyles (Shealy, Godwin, and Gardner 2017). While previous research has suggested a positive relationship between climate change awareness and pro-environmental attitudes and behaviors, this relationship may not hold uniformly across all social groups, and the degree of influence can vary depending on context and individual engagement (Ghazali et al., 2016). Higher awareness of climate change has a positive impact on demand for climate change responses, and suggests a potential relationship with the adoption of sustainable lifestyles among individuals (Venghaus, Henseleit, and Belka 2022). This is consistent with previous research indicating that students' moral obligation played a significant role in understanding their intention to engage in pro-environmental behaviors (Alshehri, 2024).

One way student behavior is formed is through the implementation of the educational curriculum. One of the courses in the tertiary education curriculum at Semarang State University is Conservation Education. This course consists of the main material, including an introduction to the environment in higher education. Conservation education courses can foster environmental awareness and encourage sustainable lifestyles among students, thereby contributing to transformative approaches to address environmental challenges and increase social responsibility (Siddiqui & Khan, 2015). Conservation education equips students with sustainable competencies, fosters awareness and practices that encourage sustainable lifestyles, thereby enhancing community resilience and environmental conservation. Conservation education at Semarang State University effectively integrates conservation values, fostering a sustainable lifestyle among students both through academic and extracurricular activities (Saddam, Zurohman, and Bahrudin 2018).

Conservation education plays an important role in shaping awareness and behavior regarding climate change. However, its effectiveness in moderating the impact of climate change awareness on sustainable lifestyles is insignificant and even unable to strengthen it. Although education can increase awareness of climate change, it does not always lead to sustainable lifestyle behaviors. Research shows that knowledge alone is not enough; behavior change requires a deeper understanding of cultural practices and engagement in society. The student demographic, which mostly lives in boarding houses, has limitations in implementing a sustainable lifestyle in society. Students, as the younger generation, actually receive knowledge about sustainable lifestyle practices more easily, for example, through participation in conservation education courses, but they often lack the skills to make informed lifestyle choices (Escobar, 2012; Lenzen & Murray, 2001). Conservation education programs need a curriculum that equips them with these skills to bridge the gap between awareness and action toward realizing a sustainable lifestyle in society. Integrated approach enriches the curriculum by providing diverse perspectives and real-world applications (Suprapto et al., 2024). The results of the research show that although environmental education, including conservation education courses, can increase knowledge of sustainable lifestyles, it cannot strengthen students' climate change awareness to improve sustainable lifestyles. This suggests that conservation education is ineffective in moderating awareness of climate change for a sustainable lifestyle (Grúňová et al., 2017). This is because having a positive attitude toward a sustainable lifestyle does not necessarily translate into concrete actions unless it is supported by psychological factors, such as personal motivation, and reinforced by social influences, such as peer norms or community support (Zaval & Cornwell, 2017).

Conservation education plays an important role in shaping pro-environmental behavior among students, but it does not sufficiently moderate the influence of such behavior on sustainable lifestyles (Tapia-Fonllem et al., 2017). The research indicates that environmental education enhances knowledge about sustainability. However, this

Knowledge does not always translate into behavior change, as individuals may lack the motivation, social reinforcement, or institutional support needed to act. One possible reason for this weak moderating effect is that conservation education curricula may focus more on cognitive learning, such as theories, policies, and ecological concepts, without incorporating practical, experiential, or community-based learning that actively shapes behavior (Ardoin et al., 2020).

Environmental education increases knowledge about sustainable lifestyles, but this does not automatically lead to behavior change, highlighting the need for a comprehensive approach that integrates education with more practical application. This shows that there are barriers to the relationship between pro-environmental behavior and sustainable lifestyles, indicating that conservation education alone is not effective in moderating this influence (Akram et al., 2023). One effort to increase conservation education's moderating influence is to develop a curriculum for learning outside the classroom and for direct practice, so that social and behavioral influences also have a slight impact on changing students' lifestyles toward a more sustainable level.

The absence of structured behavioral interventions such as eco-friendly campus initiatives, habit-tracking programs, or long-term sustainability projects may limit students' ability to integrate sustainable practices into their daily routines (Kirchner-Krath et al., 2024). Studies have shown that hands-on engagement, social modeling, and institutional reinforcement are key factors in driving long-term pro-environmental behavior change (Juma-Michilena et al., 2023). Without these components, conservation education may serve only as an informational tool rather than a transformational experience, reducing its moderating impact on sustainable lifestyles.

Despite these promising findings, it is important to recognize potential limitations. While the current assessment methods provide strong evidence of discriminant validity, future research could use multi-group analysis to assess whether discriminant validity remains consistent across demographic groups, such as gender, academic disciplines, or cultural backgrounds. Additionally, conducting longitudinal validation could help determine whether the constructs remain distinct over time, particularly in studies examining behavioral changes. Incorporating these approaches would enhance the reliability and applicability of conservation education research in promoting sustainable behavior.

Conclusion and Implications

Conservation education plays an important role in shaping pro-environmental behavior among students, but it does not moderate the influence of such behavior on sustainable lifestyles. Environmental education increases knowledge about sustainable lifestyles, but this does not automatically lead to behavior change, highlighting the need for a comprehensive approach that integrates education with more practical applications. This shows that there are barriers to the relationship between pro-environmental behavior and sustainable lifestyles, suggesting that conservation education alone is insufficient to moderate this relationship. One effort to increase conservation education's moderating influence is to develop a curriculum for learning outside the classroom and for direct practice, so that social and behavioral influences also have a slight impact on changing students' lifestyles toward a more sustainable level.

Given the limited moderating effect of conservation education on sustainable lifestyles, educational institutions must rethink and enhance the design of their conservation education programs. Traditional classroom-based environmental education, which primarily focuses on cognitive learning, should be complemented by experiential, action-oriented, and community-based learning approaches. For instance, service-learning projects, sustainability workshops, and outdoor experiential programs can provide hands-on engagement, fostering bigger behavioral change among students. Moreover, integrating behavioral interventions such as eco-campus initiatives, green competitions, carbon footprint tracking, and peer-led sustainability programs can help bridge the gap between environmental knowledge and real-world practice. Research has shown that habit formation, social reinforcement, and institutional support play crucial roles in fostering long-term pro-environmental behaviors. Universities should therefore implement structured, long-term interventions that encourage daily sustainable practices, rather than relying solely on theoretical education. Additionally, collaborations with local environmental organizations, businesses, and policy-makers can provide students with practical exposure to sustainability efforts beyond the academic setting. Internship programs, research projects addressing real-world environmental challenges, and participation in policy-making discussions can further strengthen students' commitment to sustainable living. By adopting a more holistic and applied approach, conservation education programs can move beyond knowledge transfer and actively shape students' sustainable lifestyle behaviors, ensuring that they not only understand sustainability concepts but also internalize and apply them in their everyday lives. Future curriculum development should therefore focus on integrating experiential learning, social engagement, and institutional support to enhance the overall effectiveness of conservation education in promoting sustainable lifestyles.

To enhance its effectiveness, conservation education should incorporate active learning strategies, real-world applications, and structured behavioral interventions, ensuring that students not only understand sustainability concepts but also develop habits and social norms that support a long-term lifestyle. Future research could further explore how curriculum modifications, institutional policies, and environmental incentives might strengthen the connection between pro-environmental behavior and sustainable lifestyle adoption.

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