The relationship between student environmental education, knowledge, attitude, and behavior

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Abstract
Environmental sustainability is a crucial concern for universities due to the environmental impacts of their operations, including energy use, waste, and transportation. As key actors, higher education institutions play a vital role in promoting sustainability by enhancing students' knowledge, attitudes, and active participation in sustainable practices. This study aims to analyze the relationship between environmental education, knowledge, attitude, and behavior. A total of 376 students of Universitas Negeri Semarang were involved in this study. Data were collected through questionnaires distributed online. Data analysis was carried out using the PLS-SEM analysis technique. The results showed that environmental attitude has a positive effect on student environmental behavior. However, environmental education and knowledge were not proven to significantly influence environmental behavior directly. Environmental education has been shown to play an important role in significantly increasing knowledge and attitudes towards the environment. In addition, environmental education can indirectly influence environmental behavior through the formation of environmental attitudes. The implication of this study shows that the universities and higher education policymakers need to emphasize strengthening positive attitudes toward the environment in environmental education curricula, rather than just focusing on increasing knowledge alone.

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1. Introduction

Humanity is facing a worsening systemic crisis in the ecological, social, economic, and political spheres. Today, the relationship between humans and nature is one of the most important issues for human survival (Shutaleva et al., 2022). Climate change has exacerbated global environmental problems, leading to increased public awareness and demands for government action (Piscitelli & D'Uggento, 2022). The concept of sustainability emerged in the late 20th century in response to growing concern for the environment (Zeng et al., 2023). The environmental and climate crises are increasingly becoming a central concern in humanitarian issues; therefore, environmental science and sustainable solutions have an important role and are gaining popularity globally as academic disciplines (Obrecht et al., 2022).

Environmental sustainability holds a vital role in universities due to their substantial environmental impact, including energy use, waste generation, and transportation activities (Akhtar et al., 2022), making sustainability a crucial topic in higher education with wide applications across sectors (Kim, 2023). Higher education institutions (HEIs) are key actors in fostering students' sustainability knowledge, shaping attitudes, and promoting active pro-environmental behavior (Leiva-Brondo et al., 2022). Universities carry out various initiatives to encourage such behavior, which is influenced by multiple factors and often analyzed through psychological, social, economic, and theoretical lenses (Tian & Liu, 2022). Within the Theory of Planned Behavior (TPB) framework, personal norms and perceived behavioral control significantly influence Gen Z's pro-environmental actions (Raman et al., 2024), while other studies show that energy-saving intentions are

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primarily driven by moral norms, followed by perceived behavioral control and attitudes, with subjective norms showing little effect (Du & Pan, 2021).

The TPB and Social Cognitive Theory (SCT) were shown to significantly predict students' pro-environmental behavior, with SCT showing slightly stronger prediction (Maleki et al., 2025). Based on the ability–motivation–opportunity (AMO) theory, it was found that environmental knowledge can significantly influence students' pro-environmental behavior and can act as a mediator in the influence of green human resource management practices on students' pro-environmental behavior (Akhtar et al., 2022). The Protection Motivation Theory (PMT) was used as a framework to explain pro-environmental behaviors (Shafiei & Maleksaeidi, 2020). Energy conservation attitude, subjective norms, and environmental knowledge positively affect young users' energy conservation behavior (Pop et al., 2022). This study uses TPB to explain the relationship between student environmental education, knowledge, attitude, and behavior. The TPB is a well-established social-cognitive model known for its strong explanatory power in understanding various pro-environmental behaviors. Its flexible framework also allows for broad adaptation and extension across diverse applications (He et al., 2024).

Environmental knowledge was used to predict pro-environmental behavior (Wang et al., 2021). Using a household survey and multinomial logit regression, it is revealed that environmental knowledge significantly and positively influences pro-environmental behavior (Amoah & Addoah, 2021). The results of the study indicate that students' environmental behavior is significantly influenced by environmental knowledge and attitudes (Torroba Diaz et al., 2023). Knowledge has a significant, although weak, bivariate correlation with behavior (Heeren et al., 2016). In the Indonesian context, a significant influence of environmental knowledge and responsibility on pro-environmental behavior was found (Hastuti et al., 2024). Other findings prove that students' environmental attitudes and knowledge do not have a significant effect on pro-environmental intentions, while subjective norms and perceived behavioral control of students have a positive effect on pro-environmental intentions (Correia et al., 2022). In addition, Environmental knowledge is proven to have a significant effect on environmental attitude (Torroba Diaz et al., 2023). Environmental knowledge is positively and significantly related to environmental concern, and environmental attitude can moderate the effect of environmental concern on environmental behavior (Zeng et al., 2023).

Previous studies have presented mixed results regarding the relationship between environmental knowledge and attitude towards environmental behavior (Akhtar et al., 2022; Correia et al., 2022; Torroba Diaz et al., 2023). This study attempts to continue the findings of previous researchers (Torroba Diaz et al., 2023) by replacing the environmental intelligence variable with environmental education. Environmental education is defined as a discipline or process that teaches us how to behave in ways that improve the responsible management of our environment and resources (Fang et al., 2023). A meta-analysis demonstrates the potential for environmental education to improve students' environmental knowledge, attitudes, intentions, and behavior (van de Wetering et al., 2022). Environmental education is a significant predictor of the environmental behavior of business and accounting students (Kyriakopoulos et al., 2020). In addition, the Tutor-Supported Interdisciplinary Course in Education for Sustainable Development can improve Sustainability Knowledge, Attitudes, and Behaviors (Braßler & Sprenger, 2021). Conservation education programs have been successful in engaging local communities in protecting cottonwoods (Saguinus oedipus) in Colombia as a form of pro-environmental behavior (Feilen et al., 2018).

Empirical studies indicate that environmental education contributes to increasing knowledge about waste, which is an important issue in addressing environmental problems, including in higher education (Yusuf & Fajri, 2022). Qualitative and quantitative data findings indicate that environmental education has a positive and significant influence on the pro-environmental behavior of students and teachers (Bibi et al., 2025). However, findings indicate that environmental education courses have no direct effect on environmental behavior (Widhiastuti et al., 2019). Although environmental education is provided, it does not directly encourage pro-environmental behavior. Its influence depends on psychological variables such as personal values and social norms (Tian & Liu, 2022).

This research was conducted at Universitas Negeri Semarang (UNNES), which has established itself as a conservation campus and continues to demonstrate a strong commitment to sustainability issues through its vision and mission that emphasizes a conservation perspective. UNNES actively contributes to the environmental agenda and the Sustainable Development Goals (SDGs). Recognition of this role is reflected in its achievements in UI GreenMetrics, which assesses university policies and conditions related to sustainability. Table 1 shows the results of the 2020–2024 ranking achieved by UNNES and shows significant improvement, ranking 5th nationally and continuing to rise globally. In the QS World University Rankings: Sustainability 2025, UNNES is included in the 1001–1020 ranking group. UNNES consistently develops conservation policies and encourages the formation of students who care about environmental and sustainability issues.

Table 1. UNNES ranking in UI GreenMetrics for 2020-2024

Year	National Ranking	World Ranking
2020	6	66
2021	5	43
2022	6	42
2023	5	37
2024	5	32

The implementation of conservation education courses as university courses is one of UNNES' policies in addition to other conservation programs and policy initiatives. There have been many conservation education activities and campaigns aimed at shaping students' environmental behavior, which fully support conservation and the environment. There is a special affairs office that handles conservation issues and carries out various activities, including the awarding of green schools and h-bat programs for each unit. This study aims to determine the impact of environmental education that has been implemented in shaping students' environmental behavior.

2. Method

This study aims to analyze the relationship between environmental education, knowledge, attitude, and behavior using a PLS-SEM analysis design. The population of this study was active students at Semarang State University, consisting of nine (9) faculties, namely Education and Psychology, Language and Arts, Social and Political Sciences, Mathematics and Natural Sciences, Engineering, Sports Science, Economics and Business, Law, and Medicine. The research sample was students who had taken conservation education courses as compulsory university courses. A total of 376 students became respondents in this study. The research model is shown in Figure 1.

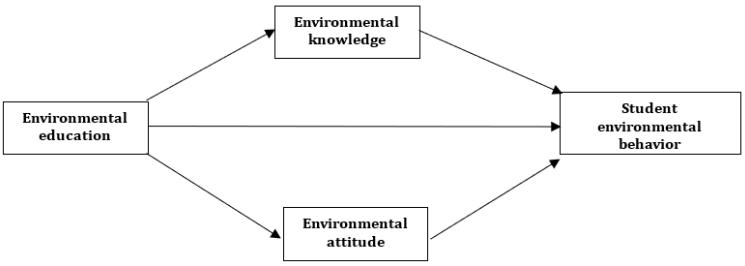

Figure 1. Research Model

The research variables consist of environmental education, knowledge, attitude, and behavior. Table 2 explains the measurement of the research variables. This research instrument was compiled based on several references from previous studies.(Radwan & Khalil, 2021; Torroba Diaz et al., 2023) which is used to measure aspects of environmental education, knowledge, attitude, and behavior. Details of the measurement of each variable are revealed in Table 1. The student environmental behavior variable consists of 10 items, environmental attitude consists of 12 items, environmental knowledge includes 5 items, and environmental education consists of 7 statement items.

Table 2. Measurement of Research Variables

Variables	Description	Number of Items	References
Student Environment Behavior	Student behavior in implementing environmental and conservation policies and programs on campus.	10	(Radwan & Khalil, 2021; Torroba Diaz et al., 2023)
Environmental Attitude	Students' attitudes towards understanding environmental and conservation issues in general, and the policies implemented by the campus.	12	(Radwan & Khalil, 2021; Torroba Diaz et al., 2023)
Environmental Knowledge	The level of student knowledge about environmental issues and campus policies on environmental and conservation issues.	5	(Radwan & Khalil, 2021; Torroba Diaz et al., 2023)
Environmental Education	Environmental and conservation education programs are implemented by the campus and integrated into the curriculum (lectures) and student extracurricular activities.	7	(Radwan & Khalil, 2021)

The data collection method in this study used a questionnaire distributed online via Google Forms to respondents. The questionnaire link was shared via student WhatsApp groups with the help of lecturers from several faculties. The questionnaire consisted of statements using a 5-point Likert scale, where a score of 1 indicates disagreement and a score of 5 indicates a very high level of agreement. Data analysis was carried out

using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method with the help of SMART-PLS software version 4.0. Model evaluation began with validity and reliability tests and continued with model feasibility testing (goodness of fit), consisting of R^2, Q^2, F^2, and SRMR (Standardized Root Mean Squared Residual) analysis. Finally, hypothesis testing was carried out to identify the relationship between environmental education, knowledge, attitude, and behavior.

3. Results and Discussion

3.1. Results

This study involved 376 students from five faculties at UNNES who completed the questionnaire completely. Details of the characteristics of the respondents are presented in Table 3. Most respondents came from the Faculty of Language and Arts, as many as 127 students (33.77%), while the smallest number came from the Faculty of Law, which was 50 students (13.30%). Respondents were dominated by women, as many as 276 people (73.40%). In addition, most of the respondents were students from the class of 2024, with a total of 232 people, or 61.70%.

Table 3. Respondent Description

Description	Frequency	Percentage
Faculty		
Language and Arts	127	33.77
Social Sciences and Politics	66	17.55
Mathematics and Natural Sciences	72	19.15
Economics and Business	58	15.43
Law	50	13.30
Total	**376**	**100**
Gender		
Female	276	73.40
Male	100	26.60
Total	**376**	**100**
Year Intake		
2021	24	6.38
2022	50	13.30
2023	70	18.62
2024	232	61.70
Total	**376**	**100**

Validity and reliability tests are shown in Table 3, Table 4, and Table 5. Based on Table 4, the factor loadings for each indicator show a number above 0.70, indicating that the items are valid. However, some items do not meet the validity criteria, so they are excluded from further analysis. There are quite a lot of items from student environmental behavior (SEB), namely SEB1, SEB2, SEB3, SEB4, SEB6, SEB7, and SEB9. Invalid environmental attitude (EA) items are EA1, EA3, EA5, and EA6. As well as environmental knowledge (EK3) and environmental education items, consisting of EE1 and EE2. Table 4 shows the results of construct reliability and validity tests, where all variables have an average variance extracted (AVE) value above 0.50, indicating that these indicators have good convergent validity in forming their respective constructs. In addition, the Cronbach's Alpha and composite reliability values of all variables are above 0.70, which indicates that the instrument used is reliable.

Table 4. Results of the Evaluation of the Model Measurement

	Items	Factor Loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Student Environmental Behavior (SEB)	SEB5	0.702	0.825	0.827	0.863	0.589
	SEB8	0.717				
	SEB10	0.713				
Environmental Attitude (EA)	EA2	0.754	0.905	0.914	0.921	0.596
	EA4	0.776				
	EA7	0.760				
	EA8	0.727				
	EA9	0.777				
	EA10	0.824				
Environmental Knowledge (EK)	EK1	0.775	0.923	0.924	0.942	0.765
	EK2	0.729				
	EK3					
	EK4	0.756				
	EK5	0.736				

	Items	Factor Loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Environmental Education (EE)	EE3	0.853	0.795	0.798	0.926	0.563
	EE4	0.877				
	EE5	0.830				
	EE6	0.879				
	EE7	0.46				

Table 5 shows the results of the Heterotrait-monotrait ratio (HTMT) analysis, and Table 6 shows the results of the goodness-of-fit model test. The HTMT value shown in Table 5 is lower than 1, which indicates adequate discriminant validity.

Table 5. Heterotrait-monotrait ratio (HTMT) results

	Student Environmental Behavior (SEB)	Environmental Attitude (EA)	Environmental Knowledge (EK)	Environmental Education (EE)
Student Environmental Behavior (SEB)				
Environmental Attitude (EA)	0.681			
Environmental Knowledge (EK)	0.511	0.873		
Environmental Education (EE)	0.491	0.736	0.803	

The results of the goodness-of-fit model are shown in Table 6 with details on the results of the R-squared, F-squared, and other model fit analyses. The R^2 value of student environmental behavior (SEB) is 0.373 and is included in the moderate influence category. The environmental education, knowledge, and attitude variables are only able to explain 37.3% of the SEB variance, while 63.7% is determined by other variables. The environmental attitude variable has the highest F-square value compared to environmental knowledge and education, so it can be stated that environmental attitude has the most dominant influence on SEB. Meanwhile, the f-square value of environmental education on environmental knowledge and attitude is greater than 0.50, so it can be stated that its influence is very high. Other results indicate that the model is quite suitable in this study, with an SRMR value of 0.077 or less than 0.08 and an NFI value of 0.713 or less than 0.90.

Table 6. Goodness-Fit-Model Results

R-Square (R^2)				
	R-square	R-square adjusted		
Student Environmental Behavior (SEB)	0.373	0.367		
Environmental Attitude (EA)	0.449	0.448		
Environmental Knowledge (EK)	0.466	0.464		
F-Square (F^2)				
	Student Environmental Behavior (SEB)	Environmental Attitude (EA)	Environmental Knowledge (EK)	Environmental Education (EE)
Environmental Attitude (EA)	0.245			
Environmental Knowledge (EK)	0.004			
Environmental Education (EE)	0.005	0.815	0.872	
Fit summary				
	Saturated model	Estimated model		
SRMR	0.077	0.090		
d_ULS	3,511	4,801		
d_G	1,050	1.126		
Chi-square	2098.765	2198.740		
NFI	0.713	0.699		

The results of hypothesis testing are shown in Table 7, which indicates that not all hypotheses can be accepted. The P value of environmental attitude towards student environmental behavior is 0.000 or less than

0.05, which indicates that environmental attitude can have a significant effect on student environmental behavior. Meanwhile, the p-value of environmental education and knowledge is 0.165 and 0.402, or more than 0.05, which indicates an insignificant effect on student environmental behavior. The p-value of environmental education towards environmental knowledge and attitude is 0.000 or less than 0.05, which means that environmental education is a significant predictor of environmental knowledge and attitude. Other results indicate that environmental education can affect student environmental behavior through environmental attitude, with a p-value of 0.000 and a coefficient of 0.411. Meanwhile, environmental education will not affect student environmental behavior if through environmental knowledge.

Table 7. Hypothesis Testing Results

	Coefficient	P values	Results
Direct Effect			
Environmental Education -> Student Environmental Behavior	0.079	0.165	Not Supported
Environmental Knowledge -> Student Environmental Behavior	-0.080	0.402	Not Supported
Environmental Attitude -> Student Environmental Behavior	0.613	0.000	Supported
Environmental Education -> Environmental Knowledge	0.683	0.000	Supported
Environmental Education -> Environmental Attitude	0.670	0.000	Supported
Indirect Effect			
Environmental Education -> Environmental Attitude -> Student Environmental Behavior	0.411	0.000	Supported
Environmental Education -> Environmental Knowledge -> Student Environmental Behavior	-0.054	0.403	Not Supported

3.2. Discussion

The findings indicate that only student attitude can determine student environmental behavior, while environmental education and knowledge do not have a significant effect. This result is in line with previous findings that showed a significant effect of environmental attitude on environmental behavior (Torroba Diaz et al., 2023). Environmental attitudes are a strong predictor of pro-environmental behaviors (Miller et al., 2022). Environmental attitudes are more predictive of pro-environmental behavior when personal costs are low or environmental benefits are high (Wyss et al., 2022). In line with other findings that green attitudes are positively related and strongly influence eco-friendly purchasing behavior (Rusyani et al., 2021). Conservation attitudes can affect young users' energy conservation behavior (Pop et al., 2022). However, there are findings that indicate an insignificant effect of the environmental attitude inventory on general pro-environmental behavior (Tamar et al., 2021). Environmental attitudes refer to students' attitudes in understanding environmental issues and conservation in general, and the policies implemented by the campus. Students who are concerned about environmental issues and sustainability will tend to have good environmental behavior. Students will try to internalize values and beliefs about the environment to behave in a way that supports conservation and is pro-environmental.

Previous researchers also found that environmental knowledge is a significant predictor of environmental behavior (Correia et al., 2022). Although there are findings that environmental knowledge has a significant effect on environmental behavior (Akhtar et al., 2022; Torroba Diaz et al., 2023; Wang et al., 2021; Zeng et al., 2023). Using a household survey and multinomial logit regression, it is revealed that environmental knowledge significantly and positively influences pro-environmental behavior (Amoah & Addoah, 2021). Environmental knowledge is proven to be a significant predictor of pro-environmental behavior and mediates the influence of hedonic, gain, and normative goals on pro-environmental behavior (Bonhi et al., 2024). Environmental knowledge shows the level of student knowledge about environmental issues and campus policies on environmental and conservation issues. Students who are aware of environmental and conservation issues tend to act in a way that supports the protection of the surrounding environment. Students will be more aware of the impact of their behavior if they are not involved in efforts to protect nature and the environment. Therefore, students strive to improve their knowledge of environmental issues and will ultimately have better environmental behavior.

Environmental education has not been proven to have a significant influence on environmental behavior. The results of the study did not support previous findings that provided empirical evidence that environmental education is a significant predictor of environmental behavior (Bibi et al., 2025; Kyriakopoulos et al., 2020). Environmental moral education was positively related to pro-environmental behavior (Begum et al., 2021). Campus programs and initiatives in lectures and outside lectures have not been able to encourage students to behave in a way that supports environmental and conservation issues. Environmental education is defined as an environmental and conservation education program implemented by the campus and integrated into the curriculum (lectures) and extracurricular activities of students.

Empirical studies indicate that environmental education contributes to improving students' environmental knowledge and attitudes. This finding is in line with previous research results showing that environmental education can improve knowledge about waste, which is an important issue in handling

environmental problems, including in universities (Yusuf & Fajri, 2022). Environmental education plays an important role in shaping environmental behavior because it provides individuals with the knowledge, awareness, attitudes, skills, and motivation needed to make environmentally responsible decisions and take meaningful actions. Environmental education will have a direct impact on environmental knowledge and attitude. In addition, environmental education will affect environmental behavior through environmental attitude. The success of environmental education programs will affect students' knowledge and attitudes first, then encourage students to have better environmental behavior.

This study uses the widely used TPB theory to understand the determinants of college students' environmental behavior (Amoah & Addoah, 2021; Maleki et al., 2025; Sehar et al., 2025). The TPB is a widely recognized social-cognitive framework with strong explanatory power for pro-environmental behavior, and its adaptable structure supports its broad use in various contexts (He et al., 2024). Drawing on theories like the Theory of Planned Behavior (TPB), researchers developed a predictive model including psychological, structural, and demographic factors, which explained 44% of the variance in pro-environmental behavior, with green self-identity emerging as the strongest psychological predictor (Hansmann et al., 2020). The results of the analysis show that the PMT construct, together with environmental attitudes, is able to explain most of the variance in pro-environmental behavior (Shafiei & Maleksaeidi, 2020).

4. Conclusion

The purpose of this study was to analyze the relationship between environmental education, knowledge, attitude, and behavior of students at Semarang State University. PLS-SEM analysis showed that environmental attitude has a positive effect on environmental behavior. Environmental education and knowledge cannot significantly determine environmental behavior. Environmental education has been proven to be able to determine environmental knowledge and attitude significantly. In addition, environmental education will affect environmental behavior through environmental attitude. The results of the study provide an understanding that the role of environmental education is very important. Although it will not directly affect environmental behavior, environmental education can improve environmental knowledge and attitude. Indirectly, the environment will determine environmental behavior through environmental attitude.

This study has several limitations, including the research model that has not analyzed the possible relationship between environmental education, knowledge, attitude, and behavior. Analysis of the moderating role of other variables, such as age, gender, and other respondent characteristics, can be included in subsequent studies. A qualitative research approach can be used to enrich the analysis and findings to understand students' environmental behavior and the factors that influence it.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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References

Akhtar, S., Khan, K. U., Atlas, F., & Irfan, M. (2022). Stimulating student's pro-environmental behavior in higher education institutions: an ability–motivation–opportunity perspective. *Environment, Development and Sustainability, 24*, 4128–4149. https://doi.org/10.1007/s10668-021-01609-4

Amoah, A., & Addoah, T. (2021). Does environmental knowledge drive pro-environmental behaviour in developing countries? Evidence from households in Ghana. *Environment, Development and Sustainability, 23*(2), 2719–2738. https://doi.org/10.1007/s10668-020-00698-x

Begum, A., Jingwei, L., Haider, M., Ajmal, M. M., Khan, S., & Han, H. (2021). Impact of environmental moral education on pro-environmental behaviour: Do psychological empowerment and islamic religiosity matter?. *International Journal of Environmental Research and Public Health, 18*(4), 1–19. https://doi.org/10.3390/ijerph18041604

Bibi, S., Nousheen, A., & Siddiquah, A. (2025). Effect of an environmental education course on prospective teachers' pro-environmental behavior: a study in education for sustainable development perspective. *International Journal of Sustainability in Higher Education*. https://doi.org/10.1108/IJSHE-09-2023-0422

Bonhi, T. C., Karim, R. Al, Sharmin, S., Jahan, N., & Chowdhury, F. (2024). Fostering pro-environmental behavior of university students through goal framing theory: the mediating role of environmental knowledge. *Global Knowledge, Memory and Communication.* https://doi.org/10.1108/GKMC-12-2023-0516

Braßler, M., & Sprenger, S. (2021). Fostering sustainability knowledge, attitudes, and behaviours through a tutor-supported interdisciplinary course in education for sustainable development. *Sustainability (Switzerland), 13*(6), 3494. https://doi.org/10.3390/su13063494

Correia, E., Sousa, S., Viseu, C., & Leite, J. (2022). Using the theory of planned behavior to understand the students' pro-environmental behavior: a case-study in a Portuguese HEI. *International Journal of Sustainability in Higher Education, 23*(5), 1070–1089. https://doi.org/10.1108/IJSHE-05-2021-0201

Du, J., & Pan, W. (2021). Examining energy saving behaviors in student dormitories using an expanded theory of planned behavior. *Habitat International*, 107. https://doi.org/10.1016/j.habitatint.2020.102308

Fang, W. T., Hassan, A., & Lepage, B. A. (2023). *The Living Environmental Education: Sound Science Toward a Cleaner, Safer, and Healthier Future*. In Sustainable Development Goals Series: Vol. Part F2745 (pp. 1–264). Springer. https://doi.org/10.1007/978-981-19-4234-1

Feilen, K. L., Guillen, R. R., Vega, J., & Savage, A. (2018). Developing successful conservation education programs as a means to engage local communities in protecting cotton-top tamarins (Saguinus oedipus) in Colombia. *Journal for Nature Conservation, 41*, 44–50. https://doi.org/10.1016/j.jnc.2017.10.003

Hansmann, R., Laurenti, R., Mehdi, T., & Binder, C. R. (2020). Determinants of pro-environmental behavior: A comparison of university students and staff from diverse faculties at a Swiss University. *Journal of Cleaner Production*, 268. https://doi.org/10.1016/j.jclepro.2020.121864

Hastuti, K. P., Arisanty, D., Muhaimin, M., Angriani, P., Alviawati, E., Aristin, N. F., & Rahman, A. M. (2024). Factors affecting pro-environmental behaviour of Indonesian university students. *Journal of Turkish Science Education, 21*(1), 102–117. https://doi.org/10.36681/tused.2024.006

He, S., Luo, Y., Qu, Y., & Hu, X. (2024). Does it work? Exploring the influence mechanism of financial incentives in cultivating pro-environmental behavior among college students. *Journal of Cleaner Production*, 436. https://doi.org/10.1016/j.jclepro.2024.140695

Heeren, A. J., Singh, A. S., Zwickle, A., Koontz, T. M., Slagle, K. M., & McCreery, A. C. (2016). Is sustainability knowledge half the battle?: An examination of sustainability knowledge, attitudes, norms, and efficacy to understand sustainable behaviours. *International Journal of Sustainability in Higher Education, 17*(5), 613–632. https://doi.org/10.1108/IJSHE-02-2015-0014

Kim, Y. H. (2023). Sustainability in Knowledge, Education, and Industry: A Case of a Hospitality and Tourism Program. *Journal of Hospitality and Tourism Education, 37*(1), 67–77. https://doi.org/10.1080/10963758.2023.2205144

Kyriakopoulos, G., Ntanos, S., & Asonitou, S. (2020). Investigating the environmental behavior of business and accounting university students. *International Journal of Sustainability in Higher Education, 21*(4), 819–839. https://doi.org/10.1108/IJSHE-11-2019-0338

Leiva-Brondo, M., Lajara-Camilleri, N., Vidal-Meló, A., Atarés, A., & Lull, C. (2022). Spanish University Students' Awareness and Perception of Sustainable Development Goals and Sustainability Literacy. *Sustainability (Switzerland), 14*(8), 4552. https://doi.org/10.3390/su14084552

Maleki, S., Naeimi, A., Bijani, M., & Salahi Moghadam, N. (2025). Comparing predictive power of planned behavior and social cognition theories on students' pro-environmental behaviors: The case of University of Zanjan, Iran. *Journal of Cleaner Production,* 486. https://doi.org/10.1016/j.jclepro.2024.144386

Miller, L. B., Rice, R. E., Gustafson, A., & Goldberg, M. H. (2022). Relationships Among Environmental Attitudes, Environmental Efficacy, and Pro-Environmental Behaviors Across and Within 11 Countries. *Environment and Behavior, 54*(7–8), 1063–1096. https://doi.org/10.1177/00139165221131002

Obrecht, M., Feodorova, Z., & Rosi, M. (2022). Assessment of environmental sustainability integration into higher education for future experts and leaders. *Journal of Environmental Management*, 316. https://doi.org/10.1016/j.jenvman.2022.115223

Piscitelli, A., & D'Uggento, A. M. (2022). Do young people really engage in sustainable behaviors in their lifestyles?. *Social Indicators Research*, 163, 1467–1485. https://doi.org/10.1007/s11205-022-02955-0

Pop, R. A., Dabija, D. C., Pelău, C., & Dinu, V. (2022). Usage intentions, attitudes, and behaviors towards energy-efficient applications during the COVID-19 Pandemic. *Journal of Business Economics and Management, 23*(3), 668–689. https://doi.org/10.3846/jbem.2022.16959

Radwan, A. F., & Khalil, E. M. A. S. (2021). Knowledge, attitude and practice toward sustainability among university students in UAE. *International Journal of Sustainability in Higher Education, 22*(5), 964–981. https://doi.org/10.1108/IJSHE-06-2020-0229

Raman, R., Das, P., Mandal, S., Vijayan, V., AR, A., & Nedungadi, P. (2024). The impact of Gen Z's pro-environmental behavior on sustainable development goals through tree planting. *Sustainable Futures*, 8. https://doi.org/10.1016/j.sftr.2024.100251

Rusyani, E., Lavuri, R., & Gunardi, A. (2021). Purchasing eco-sustainable products: Interrelationship between environmental knowledge, environmental concern, green attitude, and perceived behavior. *Sustainability (Switzerland), 13*(9). https://doi.org/10.3390/su13094601

Sehar, A., Orangzab, Akbar, M., Poulova, P., Vasudevan, A., & Huang, T. (2025). Understanding the drivers of a pro-environmental attitude in higher education institutions: the interplay between knowledge, consciousness, and social influence. *Frontiers in Environmental Science, 12*. https://doi.org/10.3389/fenvs.2024.1458698

Shafiei, A., & Maleksaeidi, H. (2020). Pro-environmental behavior of university students: Application of protection motivation theory. *Global Ecology and Conservation, 22.* https://doi.org/10.1016/j.gecco.2020.e00908

Shutaleva, A., Martyushev, N., Nikonova, Z., Savchenko, I., Abramova, S., Lubimova, V., & Novgorodtseva, A. (2022). Environmental behavior of youth and sustainable development. *Sustainability (Switzerland), 14*, 250. https://doi.org/10.3390/su14010250

Tamar, M., Wirawan, H., Arfah, T., & Putri, R. P. S. (2021). Predicting pro-environmental behaviours: the role of environmental values, attitudes and knowledge. *Management of Environmental Quality: An International Journal, 32*(2), 328–343. https://doi.org/10.1108/MEQ-12-2019-0264

Tian, H., & Liu, X. (2022). Pro-Environmental Behavior Research: Theoretical Progress and Future Directions. *International Journal of Environmental Research and Public Health, 19*(11). https://doi.org/10.3390/ijerph19116721

Torroba Diaz, M., Bajo-Sanjuan, A., Callejón Gil, Á. M., Rosales-Pérez, A., & López Marfil, L. (2023). Environmental behavior of university students. *International Journal of Sustainability in Higher Education, 24*(7), 1489–1506. https://doi.org/10.1108/IJSHE-07-2022-0226

van de Wetering, J., Leijten, P., Spitzer, J., & Thomaes, S. (2022). Does environmental education benefit environmental outcomes in children and adolescents? A meta-analysis. *Journal of Environmental Psychology, 81*. https://doi.org/10.1016/j.jenvp.2022.101782

Wang, Y., Hao, F., & Liu, Y. (2021). Pro-environmental behavior in an aging world: Evidence from 31 countries. *International Journal of Environmental Research and Public Health, 18*(4), 1–13. https://doi.org/10.3390/ijerph18041748

Widhiastuti, R., Setiyani, R., Kardiyem, & Rahmaningtyas, W. (2019). The role of responsibility feeling in mediating the effects of the environmental education course, socio-economic conditions, and awareness as the caliph on environmental behavior. *Journal of Environmental Management and Tourism, 10*(1), 53–62. https://doi.org/10.14505/jemt.v10.1(33).06

Wyss, A. M., Knoch, D., & Berger, S. (2022). When and how pro-environmental attitudes turn into behavior: The role of costs, benefits, and self-control. *Journal of Environmental Psychology*, 79. https://doi.org/10.1016/j.jenvp.2021.101748

Yusuf, R., & Fajri, I. (2022). Differences in behavior, engagement and environmental knowledge on waste management for science and social students through the campus program. *Heliyon, 8*. https://doi.org/10.1016/j.heliyon.2022.e08912

Zeng, Z., Zhong, W., & Naz, S. (2023). Can Environmental Knowledge and Risk Perception Make a Difference? The Role of Environmental Concern and Pro-Environmental Behavior in Fostering Sustainable Consumption Behavior. *Sustainability (Switzerland) , 15*, 4791. https://doi.org/10.3390/su15064791