International Journal of Environmental Impacts
https://www.acadlore.com/journals/IJEI

Exploring Student Perceptions of Pro-Environmental Behavior in Outdoor Learning: A Mixed-Method Investigation

Rima Meilita Sari[1*], Ridhwan Ridhwan[2], Tengku Muhammad Sahudra[1], Faiz Urfan[1], Karunia Puji Hastuti[3]

[1] Geography Education Program, Department of Social Science and Humaninites Education, Universitas Samudra, 24416 Langsa, Indonesia
[2] Geophysics Study Program, Department of Science, Universitas Samudra, 24416 Langsa, Indonesia
[3] Department of Geography Education, Universitas Lambung Mangkurat, 70124 Banjarmasin, Indonesia

[*] Correspondence: Rima Meilita Sari (rima.melita.sari@unsam.ac.id)

Received: 05-23-2025 **Revised:** 07-21-2025 **Accepted:** 08-27-2025

Citation: R. M. Sari, R. Ridhwan, T. M. Sahudra, F. Urfan, and K. P. Hastuti, "Exploring student perceptions of pro-environmental behavior in outdoor learning: A mixed-method investigation," *Int. J. Environ. Impacts.*, vol. 8, no. 6, pp. 1325–1338, 2025. https://doi.org/10.56578/ijei080618.

Abstract: This study aims to examine students' pro-environmental behavior and analyze the influence of outdoor learning experiences on pro-environmental behavior, as well as to identify differences in pro-environmental behavior across gender and home location. This study employed a mixed methods approach involving 206 undergraduate students from several universities in Indonesia. Data were collected through a questionnaire and an interview. The questionnaire assessed students' pro-environmental behavior, and the data were analyzed using descriptive statistics, the Mann-Whitney U test, and thematic analysis. The results indicated that students'pro-environmental behavior was at a moderate level. Outdoor learning has a significant influence on improving students' pro-environmental behavior through mobility actions. Pro-environmental behavior does not show differences when viewed from gender differences. On the contrary, there is a difference in pro-environmental behavior when viewed from different home locations. Despite the benefit of outdoor learning, challenges remain, including teacher preparedness, time constraints, and inadequate facilities. Detailed findings are discussed in the main section of the article.

Keywords: Gender; Home location; Mixed method; Outdoor learning; Pro-environmental behaviour

1 Introduction

Advances in technology have led to human actions that affect the environment. Several research reports show that human actions are feared to damage the environment and have long-term effects on the quality of life [1–3]. For example, climate change, biodiversity decline, and ecosystem degradation show the need for serious attention [4–6]. One of the solutions in dealing with environmental problems is through education. Education plays a strategic role in shaping the environmental awareness of the younger generation [7]. Environmental education is able to provide knowledge and improve skills to support a sustainable environment [8, 9].

Environmental education through learning has been widely practiced and proven to increase environmental knowledge in students [10–12]. However, outdoor learning is still interesting to study, especially testing the results of program effectiveness. Outdoor learning allows students to learn contextually through observation and constructing knowledge, thus building students' emotional attachment to the environment [13]. Recent research found that outdoor learning is able to bridge theory and practice, thus increasing learning motivation [14]. Furthermore, other findings elaborate that outdoor learning is able to increase social and environmental sensitivity [15]. However, there are still gaps in the implementation of outdoor learning in various countries [16, 17].

Previous studies highlighted the influence of outdoor learning on students' environmental knowledge and skills [18, 19]. However, few studies have examined pro-environmental behavior. Pro-environmental behavior is needed to solve environmental problems [20]. As research [20, 21] mentioned, students who can already show pro-environmental behavior also have good environmental knowledge. Several studies have measured pro-environmental behavior in both the general public and students [22–24]. Although studies such as those from Alshehri [20] and Granda et al. [25] have highlighted differences in perceived pro-environmental behavior in terms of gender, the influence of outdoor learning has not been explored in this context. Furthermore, gaps in other demographic factors

have not been highlighted, such as location of origin. Therefore, this study addresses the gap through mixed methods into an in-depth analysis of outdoor learning and student perceptions in terms of demographic factors of gender and home location.

Information on the influence of outdoor study on pro-environmental behavior in terms of gender and home location is important for determining strategic studies on environmental education curriculum development and improving students' pro-environmental behavior. Demographic factors can influence students' knowledge in environmental conservation efforts [26, 27]. Thus, the study of influencing factors such as gender and home location is needed to design learning recommendations that can improve pro-environmental behavior. Thus, the questions to be answered in this study are: (1) What is students' initial perception of pro-environmental behavior? (2) How does outdoor learning influence students' pro-environmental behavior? (3) Are there significant differences in pro-environmental behavior based on gender and home location after outdoor learning? What challenges do students encounter during outdoor learning activities? Accordingly, this study has the main objective of investigating students' pro-environmental behavior and the effect of outdoor learning to improve students' pro-environmental behavior. Specifically, this present research study objectives are:

(1) To examine students' perception of pro-environmental behavior;

(2) To analyze the effect of outdoor learning on students' pro-environmental behavior;

(3) To determine the influence of gender and home location on pro-environmental behavior after participating in outdoor learning; and

(4) To identify the challenges faced by students in participating in outdoor learning.

2 Methods

The research used a mixed-methods approach to gain deeper understanding of the research findings, particularly regarding the challenges students face during outdoor learning. The research was conducted in several universities that have Environmental Geography as a compulsory course. The mixed research design, especially the qualitative approach, aims to provide additional knowledge to the findings that cannot be explained only by quantitative data. The use of qualitative data provides in-depth explanation and understanding of the research results and was important to do in this study [28]. Qualitative data collection was conducted after quantitative data collection to ensure internal validity and avoid bias [29], thereby the use of qualitative data, is able to describe the results of quantitative data to be more easily understood.

To answer the research question about the effect of outdoor learning on students' pro-environmental behavior, the study used an experimental design using a one-group pretest and posttest design. The one-group pretest and posttest design was chosen due to limitations in practice in the field. all students who take the Environmental Geography course are compulsory and actual participants, making it impossible to create a control group and provide restrictions on the learning rights of each student. In addition, the pretest post-test control group design is commonly used in research to evaluate behavior change before and after intervention. A total of 6 classes from 3 different universities in Aceh Province, Indonesia, were involved in this activity. The selection of the three universities was based on the representation of geographical and social contexts. The three universities represent the condition of students from urban and rural backgrounds who are able to answer the research questions well, where the three universities have students who come from areas, urban, semi-urban, throughout Aceh to northern Sumatra. University A is located on the coast of Aceh and has students spread from the east coast of Aceh to North Sumatra, University B is in an urban area with the majority of students from semi-urban areas on the west coast of Aceh, then University C is located in the capital city of Aceh Province and can represent students in Aceh and Sumatra areas. This selection was designed to ensure a varied and empirically relevant representation of the data.

The research involved students who were and had been learning environmental geography courses at three universities in Indonesia. The students involved as research samples have obtained permission from lecturers and academic supervisors at the university. A total of 2300 students who have a compulsory course, namely environmental geography, then obtained a final sample of 206 students, consisting of 115 men and 91 women. The sample size was determined based on the total population enrolled in the course from the three universities. The validity of the sample of 206 was based on a statistical power analysis that showed the adequacy of the research sample. The sample power analysis using G*Power 3.1 software shows the adequacy of the sample in accordance with this study. The result of the power analysis was <0.80 with a significance level of 0.05 to detect effect size. To see the comparison between the two groups resulted in a value of 0.946, so the sample size is appropriate for detecting moderate to large effect sizes in the Wilcoxon test and Mann-Whitney U test. All students who became the sample were then given a questionnaire containing demographic data to obtain the location of the house. A total of 104 students whose homes were located in urban areas, while a total of 102 students whose homes were located in rural areas.

The selection of participants involved in the interviews was done using a targeted approach. The researcher analyzed the unique answers that had been answered by all students, and then the target students interviewed were purposively selected to conduct in-depth interviews. A total of 10 students were involved in the in-depth interviews,

consisting of 5 males and 5 females, to provide a balanced representation of both genders. The interviewed students will provide valuable insights and knowledge to add explanations to the research findings collected through the distribution of questionnaires. The demographic characteristics of the students are summarized in Table 1.

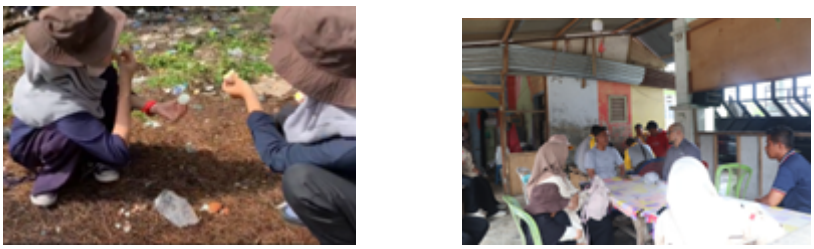
Table 1. Demographic characteristics

Demographic Characteristics		Questionnaire	Interview
Gender	Male	115	5
	Female	91	5
	Total	206	10
Home location	Rural	102	4
	Urban	104	6
	Total	206	10

All participants provided consent prior to data collection. Before data collection began, each student provided an informed consent that outlined the purpose, procedures, and potential risks of their involvement in the study. They also agreed that the data collected should be anonymized and stored in a safe place.

Outdoor learning was conducted for 12 meetings over 3 months, from May to July 2024. The outdoor learning was conducted in the Environmental Geography class with the learning material "Analyzing and Finding Solutions to Household Waste Problems in Indonesia." Each meeting was held for 120 minutes.

Outdoor learning involved 6 classes as experimental groups. There are 5 steps of outdoor learning, namely orienting, questing, mapping, sharing, and evaluating. To support outdoor learning to achieve learning objectives, researchers provide student worksheets that contain instructions for implementing outdoor learning activities and investigation instructions. Students learn to investigate the problems presented on the student worksheet (Figure 1). The lecturers provide different problems at each meeting.



(a) (b)

Figure 1. Outdoor learning activities: (a) Orientation to the problem; (b) Investigation into the community

Data collection used the General Ecological Behavior Scale (GEBS) questionnaire from Kaiser [30]. The use of the GEBS instrument has been carried out by several previous studies [31–33], so the reliability of the nstrumenti s stronger than other measurement instruments. The questionnaire consisted of 32 statements with frequency responses on a 5-scale from 1 (never) to 5 (very often) and 18 statement items with yes and no responses. The questionnaire assessed 6 types of behavior, namely Energy conservation, which is an indicator that assesses actions such as minimizing the use of air conditioning and capturing energy-saving behaviors that are inexpensive, routine, and essential for a sustainable lifestyle. 2) Mobility and transportation, which measures preferences for transportation modes, particularly the use of public transportation, and strategic behaviors in mitigating climate degradation related to emissions generated by the transportation sector, 3) Waste avoidance, which describes waste management and the use of reusable items, 4) Consumerism, which highlights preferences for purchasing environmentally friendly products and consumption choices that support sustainability, 5) recycling, which covers behavior in downstream waste management and participation in recycling programs, and 6) social behavior toward conservation, which highlights the dimensions of student participation and willingness in activities and organizations related to environmental conservation efforts. These six indicators were selected to represent pro-environmental actions carried out daily that can be measured and modified through educational interventions. These indicators align with the research objectives focused on evaluating the effectiveness of outdoor learning in promoting pro-environmental knowledge and behavior. The questionnaire was translated into Indonesian and adjusted to the characteristics of students.

To keep the instrument reliable in measuring the research variables, the questionnaire was consulted with learning and psychology experts. The approved questionnaire was then tested on 100 geography education students in the 3rd academic year. Validity and reliability tests were conducted simultaneously but with different methods for each scale. We separated the Likert and Gutman scales in the analysis, so the Likert scale validity analysis used Pearson

correlation, and the Likert scale reliability analysis used Cronbach's alpha. While the validity analysis of the Guttman scale uses Pearson correlation, the reliability analysis of the Guttman scale uses KR-20. The results of the Likert scale questionnaire analysis showed that the instrument contained 25 valid items with a value of 0.249–0.977 and a reliability value of 0.946. While the validity test of the Guttman scale resulted in 14 questions that were considered valid with a score of 0.231–0.978 and the reliability value was 0.918. The questionnaire was then distributed using Google Forms and shared as a shared link with 3 main sections, namely participant information, a consent form, and GEBS questions. The questionnaire was distributed before outdoor learning (pretest) and after indoor learning (posttest). Students were asked to answer the questionnaire for 10 minutes before outdoor learning for the pretest and after outdoor learning (posttest).

The study used semi-structured interviews to understand students' views on the challenges of outdoor learning studies and reasons for pro-environmental behavior reported through the GEBS questionnaire. The interview protocol was developed based on the literature and survey items. Interviews were conducted using Zoom meetings. Each call was recorded with the consent of the participants. Transcripts were translated from Indonesian to English. Interview results were thematically analyzed using procedures from Braun and Clarke [34].

Quantitative data analysis used statistical analysis with percentage technique to see the initial perception of pro-environmental behavior. To see the effect of outdoor learning on pro-environmental behavior, a one group pretest-posttest design was used. Before conducting inferential statistical tests, the data were tested for normality using the Kolmogorov-Smirnov test. The test results showed that the data were not normally distributed (p = 0.000; p < 0.05). Therefore, the Wilcoxon signed rank test was used to compare the pretest and posttest scores. Furthermore, to see the effect of pro-environmental behavior in terms of gender differences and home location, the study used non-parametric statistical tests using the Mann-Whitney U test. This test is appropriate for ordinal data that does not meet parametric assumptions. However, nonparametric statistical tests have limitations, namely analyzing ranks, which causes difficulties in interpreting effect sizes. Nevertheless, considering the sample size and the non-normal distribution of the data, non-parametric statistical tests are appropriate for this case. For qualitative data, it was analyzed by reading interview transcripts and identifying important features and assigning codes and looking for code attachments within larger themes.

3 Results and Discussion

The data obtained from this study were analyzed by descriptive statistics and can be seen in Table 2 and Table 3. A total of 206 students were involved and considered for analysis on each item.

3.1 Initial Perception of Pro-Environmental Behavior in Students

The results of the initial perception study were conducted before students received out-of-class learning. We used 2 scales according to the GEBS instrument model. We counted agree and strongly agree answers as positive responses. The descriptive statistical analysis is reported in Table 2 and Table 3.

Before outdoor learning was implemented, students' responses to pro-environmental actions showed moderate attitudes. Based on the results of the analysis in Table 2 and Table 3, it can be seen that before outdoor learning was implemented, the average student only showed moderate concern. The highest score was seen in energy-saving practices, where many positive responses were described. This can be seen in the students' positive responses to wearing thin clothing on hot days and utilizing natural ventilation. This aligns [35] reporting that lower-cost actions are preferred. Findings before the learning intervention described a gap between knowledge and action. Students' response patterns confirmed the need for an intervention. As found in study [10], learning demonstrated transformative steps to enhance action.

3.2 The Effect of Outdoor Learning on Students' Pro-Environmental Behavior

In order to determine the effect of outdoor learning, it was analyzed using a one-group pre-test post-test design. The normality test using the Kolmogorov-Smirnov test shows that the data is not normally distributed (p-value $<$ 0.05), so it used Wilcoxon signed-rank test analysis. The results of statistical calculations can be seen in Table 4.

Based on the results of data analysis of pretest and posttest learning using outdoor studies, the Z score value has a negative value, which means that the posttest value is greater than the pretest. When viewed from the p-value of each indicator shows that the p value < 0.05 which means there is a significant difference between the pretest and posttest. So it can be concluded that outdoor learning has an effect on students'pro-environmental behavior. When analyzed using effect size, it shows that outdoor learning has a large effect (r > 0.5) on students' pro-environmental behavior.

Students agree that geography learning in particular should instill a caring attitude towards the environment through developing content contextually. As one female student explained,"*I am usually only given concepts about what the environment is: abiotic and biotic environments. So understanding in action is rather difficult.*" The response of one male student showed a similar result. "*I know that resources will be depleted quickly if not preserved. However, what I don't know rigin to practice protecting these resources.*"

The responses above show that students are interested in further environmental learning. Especially in relation to actions that can be taken in daily activities. Furthermore, students' interest is no longer in concepts related to material about the environment but rather in actions. These findings are in line with experiential learning theory, which suggests that direct involvement in real-world experiences can promote deeper knowledge and attitudes [14]. Several other studies have also highlighted that experiential learning in the environment can improve pro-environmental behavior. At the same time, this study shows that outdoor learning has advantages not only in terms of increasing knowledge, but also in terms of pro-environmental behavior. The findings show that students' initial perceptions of pro-environmental behavior show varying levels in various indicators.

Table 2. Descriptive statistics of pro-environmental behavior (Likert scale questionnaire items)

Indicator	Statement	Response					N*
		1	2	3	4	5	
Energy saving	I wait for the clothes in the washing basket to be full before washing my clothes.	9	25	30	19	17	74
	In the dry season, I open doors and windows to air out or cool the room.	7	17	35	29	12	84
	I do not use a hair dryer.	8	23	43	22	4	54
	In the dry season, I turn off the fan or air conditioner if I leave the house for more than 4 hours.	6	30	39	17	9	52
	I do not take a bath.	0	19	37	34	9	90
Mobility	I never ride my motorcycle, always if walking in the city.	0	18	38	29	15	38
	I drive no more than 100 km/h on the highway.	3	13	40	33	11	33
	I use public transport/bicycle if walking to the nearest area of about 30 km.	0	7	50	35	9	12
	I turn off the motorcycle engine when there is a traffic jam.	0	16	63	20	1	32
	I turn off the motorcycle engine when at a red light.	0	8	72	19	1	16
Avoiding waste	I never buy drinks in cans.	1	16	53	26	4	34
	I refuse if offered a plastic bag when shopping at the store.	3	24	56	15	2	56
	I buy reusable bottles instead of disposable ones.	1	11	50	34	4	24
	I buy products in refillable packaging.	2	11	48	33	6	26
Consumption	I buy meat or products labeled as environmentally friendly.	13	19	39	27	2	65
	I do not use oven cleaner spray to clean my oven.	0	9	27	38	26	18
	I do not like to buy ready-to-eat meals.	1	25	48	24	2	53
	I buy fruits and vegetables according to the season.	0	20	66	14	0	42
	I get rid of insects using an insect swatter.	0	8	44	39	9	16
Recycling	I bring empty bottles to the recycling bin.	27	28	25	13	7	114
Commitment	I show my environmental behavior to friends.	23	19	27	24	7	88
	I make financial contributions to environmental organizations.	2	7	14	43	34	18
	I do not buy products from companies whose backgrounds are not ecological.	4	19	46	25	6	48
	I read books, informational brochures, and other materials on environmental issues.	2	23	36	33	6	52
	I talk with friends about environmental pollution, climate change, and/or energy consumption.	0	31	43	24	2	63

Note: 1: Strongly disagree; 2: Disagree; 3: Undecided; 4: Agree; 5: Strongly agree; N: Number of positive responses.

Table 3. Descriptive statistics of pro-environmental behavior (Guttman scale questionnaire items)

Indicator	Statement	Response		N*
		Yes	No	
Energy saving	In the dry season, I wear light clothes, so I don't need to turn on the air conditioner/fan.	58	42	119
	If I don't get dirty, I don't change my towels.	44	56	90
	I installed energy-efficient lights in all rooms of the house.	50	50	104
	I turn off the lights and open the windows during the day.	40	60	82
Mobility	I don't have a car.	75	25	155
Avoiding waste	I reuse my shopping bags.	50	50	104
Consumption	I don't use fabric softener in my laundry.	29	71	60
	I don't use chemical fragrances in the bathroom.	42	58	87
	I am a vegetarian.	46	54	95
Recycling	I don't throw empty batteries in the household waste bin.	52	48	108
	After eating, I dispose of food waste in the organic waste bin.	65	35	134
Commitment	I am a member of an environmental organization.	24	76	50
	After a picnic, I leave the place as clean as all.	33	67	69
	I obtain electrical energy from renewable energy sources.	16	84	33

Note: N: Number of positive responses.

Table 4. Descriptive statistics of pro-environmental behavior (Guttman scale questionnaire items)

Indicator	Z	Asymp. Sig (2-Tailed)	r
Energy saving	-12.408	0.000	0.869
Mobility	-12.340	0.000	0.868
Avoiding waste	-12.408	0.000	0.869
Consumption	-12.404	0.000	0.868
Recycling	-9.499	0.000	0.786
Commitment	-12.402	0.000	0.868
Total pro-environmental behavior	-12.388	0.000	0.867

3.2.1 Energy saving

This energy-saving question relates to the use of electronic devices and systems in washing clothes. Students had a positive attitude towards energy-saving measures after carrying out outdoor learning. Students had a positive attitude after the lesson. Quantitative data results show a significant increase in energy-saving actions after outdoor learning, with a Z-value = -12.408 and r = 0.869. These results indicate that outdoor learning substantially increases sensitivity to energy conservation. Qualitative data further supports these findings, noting that students' energy-saving behaviors have changed, such as turning off lights and air conditioners and utilizing natural ventilation during the day. One male student stated that "*I am a boarding student, so activities on campus make me more active outside my room. I turn off the air conditioner during outdoor activities*." Furthermore, another male student also said "*At home, I started to install energy-saving lights and consider opening doors and windows during the day. In addition to saving energy, my actions are also due to my awareness, so I can also save economically*."

Outdoor study learning provides students with direct experience interacting with the environment. Learning activities help students understand how to use energy more efficiently. This finding is in line with previous research that it is easier to show pro-environmental behavior if the activity is easy to do and economically profitable [35, 36].

3.2.2 Mobility

The theme related to mobility is the use of transportation to support daily activities. The quantitative findings show Z value = -12, that there is a significant effect of outdoor learning. Students demonstrate a preference for modes of transportation with lower emissions. When asked about the use of cars. All students who became interview subjects said they did not have one, or they had one, but it was not in their personal name (parents' car). Furthermore, when asked about the use of motorbikes when traveling, students' answers were more diverse. One female student said, "*I always use a motorcycle because the distance between home and campus is quite far. In addition, the influence of the hot weather makes me lazy to walk*." A male student also said, "*Motorbikes are the right choice, in my opinion, because they are time efficient. If we wait for public transportation, then we have to spend more time waiting for the public transportation*." Furthermore, there were answers that showed more environmentally-friendly behavior, such

as the male student's answer, "*I always use a bicycle if I want to go to various places. I think cycling is much healthier and more economical*."

Since outdoor learning was implemented, there has been a change in students' habits regarding transportation choices. As explained by a female student "*Since this outdoor learning, I have gotten used to walking to campus. Finally, by walking, I enjoy the campus atmosphere more, greet each other, and can be more relaxed*". Based on the results of the interviews, it is known that there are other factors in mobility, namely student economic factors, as well as social relationships with friends and family. This finding shows that there are other factors influencing pro-environmental behavior than social relationships and economic factors. These results strengthen the research findings from Mackay and Schmitt [37] which stated that outdoor learning has an effect on increasing environmental awareness. As mentioned by the studies [37–39], environmental education is not enough to just provide theory but requires efforts to encourage changes in student behavior to pro-environmental behavior.

3.2.3 Avoiding waste

The students felt that after doing outdoor learning, their attitude became more thoughtful in the use of disposable packaging. The theme related to the use of disposable plastic items is very interesting because it is contextualized in students' daily lives. Quantitative results show a Z value = -12.408, p < 0.000, and r = 0.869 indicating a significant effect of outdoor learning. Students demonstrated independence by bringing reusable shopping bags and refusing plastic shopping bags. Female students demonstrated this by stating, "*When shopping, I now prefer recycled packaging*." Other female students also demonstrated that in addition to bringing shopping bags, they brought refillable water bottles, "*I always bring my own grocery bag, which is practically folded in a bag, and I always bring a refillable drinking bottle*."

Based on the research findings, outdoor learning provides them with practical efforts in avoiding waste, especially in the use of non-recycled plastic wrappers. This practice reflects how outdoor learning makes students more aware and consistent in protecting the environment. This is in line with research from Syed-Abdullah [40] showing that active involvement in outdoor learning significantly increases knowledge and encourages consistent pro-environmental behavior. In line with that, the studies [41, 42] revealed that environmental identity can develop with active participation, reflection, and direct experience so as to build an emotional connection with the environment, which can internalize the value of sustainability.

3.2.4 Consumption

Themes related to consumption include food selection and cleaning. Students showed an increase in awareness of consumption (Z = -12.404, r = 0.868). Students said they preferred to buy seasonal fruits. As one female student said, "*I like to buy fruit when it's in season, not only is there a lot of choice, but the price rigini relatively cheaper at the market. I am also used to being taught by my parents how to choose good-quality fruit*."

In addition to asking about food selection, we also wanted to know the consumption patterns of students. According to them, consuming more vegetables affects environmental conservation efforts. As mentioned by a male student, "*I like vegetables and usually buy them at a kiosk near my boarding house because they are healthier*." According to him, consuming vegetables is healthier and contributes to environmental conservation efforts. Students also indicated that they prefer to kill insects with an insect swatter rather than a liquid spray. As one student explained,"*I don't fully understand, but I prefer to use an insect swatter rather than a liquid spray. I'm a bit afraid of particles getting into my food or utensils and then accidentally getting into my body*."

However, pro-environmental attitudes are also influenced by factors other than learning, such as socio-cultural factors and family habits. As one female student replied, "*There are many meat vendors near my house. My family and I are used to eating meat. I don't think it's a problem and it doesn't affect the environment. No one in my family has contracted the virus due to eating a lot of meat*." The findings show that out-of-school learning has influenced their attitudes in food selection. However, there are external factors, such as family habits, that influence their consumption patterns. As shown in the research [24] environmental education influences pro-environmental behavior; however, to demonstrate long-term change, it is necessary to reinforce environmental conservation values through other factors.

3.2.5 Recycling

Recycling activities increased after outdoor learning with Z value = -9.499 and r = 0.786. The students have seen a change in their environmental care attitude from the act of recycling goods by the way they do waste segregation to temporary waste disposal. As mentioned in an interview with a female student, "*After participating in this lesson, I recycle almost everything that I can recycle such as unused paper, bottles, and then invite my younger siblings, brothers, and friends to do the same movement*" Similar responses were also expressed by male students "*Before, when I saw garbage, I only thought of throwing it in the trash. Now, when I see waste, I think of categorizing whether it can be recycled or not, and if it is recycled, whether it can generate economic value*."

The responses show that students' perceptions show an increase in the application of pro-environmental attitudes. Students already have control over their behavior in recycling waste, especially increased understanding and skills in

waste sorting. They realize that small actions affect big changes to the environment. Outdoor learning provides real experiences to students, thus providing practical insight into environmental conservation efforts [18, 43].

3.2.6 Commitment

Outdoor learning activities have an impact on increasing students' commitment to efforts to protect and preserve the environment. Significant changes were shown in the survey results (Z = -12.402 and r = 0.868) and interviews. Outdoor learning provides positive examples of how they behave and take part in positive actions in environmental programs. As explained by one of the female students "*Now, I am interested to join the green campus program implemented by my campus. I am voluntary and willing to attend online lectures related to efforts to create a green environment. This is because I want to reuse things and plant trees*." Similarly, one male student replied, "*On my campus there is a "waste savings" program. Although this program is not mandatory in the course, I always contribute by both giving and helping to sort waste*." Overall, their commitment has increased, as shown by their attitude of participating in organizational activities regardless of the fact that these activities are not included in the courses they are taking. Students also feel that they have the ability to take concrete actions in an effort to educate the community, such as waste recycling, energy saving, and environmental cleaning campaigns around campus and home or boarding houses. This was revealed by one of the female students "*I have become a member of the environmental organization on campus. I voice the environmental movement by distributing brochures, campaigning, and helping to educate the public regarding household waste recycling*."

Students perceive that outdoor learning has increased their interest in joining environmental communities and joining campaign movements to educate the public to protect the environment. Outdoor learning is contextual, which involves deep emotional and social aspects. The involvement of these factors strengthens the emphasis on the importance of learning by doing for the formation of student attitudes [44]. Learning with real experiences in nature can encourage pro-environmental behavior [45]. This is because exposure to the outdoor environment makes students able to show concern through student experiences, thus becoming an important factor in promoting pro-environmental behavior.

3.3 The Effect of Gender and Home Location on Pro-Environmental Behavior after Outdoor Learning

To determine the effect of gender and home location, we conducted a normality test on pro-environmental behavior after learning using outdoor learning. The normality score shows $p < 0.05$, which means the data is not normal. Therefore, the test uses the Mann-Whitney U test. The findings of the effect of gender on pro-environmental behavior after participating in learning can be seen in Table 5.

Table 5. Gender influence on pro-environmental behavior

Indicator	Mann-Whitney U	Wilcoxon W	Z	p	r
Energy saving	4509.00	8695.00	-1.742	0.081	0.121
Mobility	4314.50	8500.50	-2.188	0.029	0.152
Avoiding waste	5082.00	9268.00	-0.361	0.718	0.025
Consumption	4760.00	11430.00	-1.130	0.259	0.078
Recycling	5191.50	11861.50	-0.101	0.919	0.007
Commitment	4554.50	8740.50	-1.630	0.103	0.113
Total pro-environmental behavior	4857.50	9043.50	-0.088	0.377	0.006

Based on the field findings, gender differences did not show a significant influence on students' pro-environmental behavior (seen from the overall total score). Pro-environmental behavior when viewed from gender differences after treatment using outdoor learning shows that no significant differences were found. This shows that gender may have an effect, but not entirely. In the findings in the field, there was no difference in grouping between women, so that students get the same responsibility related to recycling activities, energy saving, and consumption. As shown by research from [26, 46], which concluded that gender has a very small role in pro-environmental behavior compared to other factors.

However, if analyzed more deeply, male and female students have a difference in influence on mobility (p = 0.029, $p < 0.05$) with a small effect ($r < 0.30$). Women are more likely to use public transportation than private transportation and avoid traffic jams. This finding is consistent with research from Alfaro et al. [47] which shows that women tend to choose public transportation because of safety factors and social norms. Furthermore, Stofejová et al. [48] revealed that women's environmental risk perceptions are higher, thus encouraging actions to carry out low mobility. The findings also support the theory of contemporary ecofeminism from Gaard [49] which shows that in the digital era, gender differences in environmental concerns are decreasing. Although the research [50] highlights that women show more environmental concerns. However, technological developments have caused women and men to have the same opportunities to access information [51].

On the other hand, when viewed from the difference in home location, it has a significant influence on pro-environmental behavior. It can be seen in Table 6.

Table 6. Effect of home location on pro-environmental behavior

Indicator	Mann-Whitney U	Wilcoxon W	Z	p	r
Energy saving	3565.00	8725.00	-4.877	0.000	0.340
Mobility	202.50	5662.50	-12.078	0.000	0.842
Avoiding waste	1941.00	7401.00	-8.015	0.000	0.559
Consumption	1500.00	6960.00	-9.032	0.000	0.629
Recycling	3666.00	8919.00	-4.011	0.000	0.279
Commitment	5166.50	10626.50	-0.328	0.743	0.023
Total pro-environmental behavior	811.00	6271.00	-10.519	0.000	0.733

Based on the field findings of pro-environmental actions when viewed from differences in home location, it shows a significant difference between students who come from villages and students who come from cities. This is shown in the actions of energy saving, mobility, avoiding waste, consumption, and recycling with a significance value (p = 0.000, $p < 0.05$). The recycling action shows a low effect with a value of r = 0.27, while the energy-saving action shows a moderate effect with a value of r = 0.340. The actions of mobility, avoiding waste, and consumption show a large effect with a value of $r > 0.50$ (mobility = 0.842, avoiding waste r = 0.559, and consumption r = 0.629). So that when viewed from the overall indicator shows that there is an influence of home location on pro-environmental actions with a large effect of r = 0.733. Since it is known that there is an effect of location origin in the analysis, we checked the median in the non-parametric analysis to find out which location region is superior. The results of the analysis can be seen in Table 7.

Table 7. Median analysis of the effect of home location on pro-environmental behavior

Indicator	Median		Mean	
	Urban	Rural	Urban	Rural
Energy saving	27.00	28.00	26.42	27.49
Mobility	21.00	25.50	21.04	25.14
Avoiding waste	18.00	20.00	18.06	19.87
Consumption	25.00	27.00	24.42	26.96
Recycling	6.00	6.00	6.19	5.50
Commitment	26.00	26.00	25.91	25.89
Total pro-environmental behavior	123.00	131.00	122.05	130.85

Based on the results of the analysis, it is known that students from villages are superior to students from cities. It is shown from the median of the total score of pro-environmental behavior of city students of 123.00, while students from villages are 131.00. Likewise, when analyzed based on indicators of energy saving, mobility, avoiding waste, and consumption, it shows that students from villages have more pro-environmental behavior actions than students whose homes are in urban areas. Students from rural areas are superior to students from urban areas, especially in energy-saving actions, mobility, actions to avoid waste, and consumption. This difference is due to the high relationship between rural students and nature. Such as the findings [52] show that conservation management practices are greater in rural communities. Research findings [53] show that people from rural areas show positive dependence on nature by showing the diversity of local wisdom in environmental conservation. In addition, limited rural infrastructure forces students to get used to adapting to sustainability [54].

However, when viewed from the recycling indicator, students from urban areas have the same actions compared to students from rural areas. After analyzing based on the average, it shows that the recycling actions of students whose home location is from the city are better than students whose home location is from the village ($6.19 > 5.50$). This shows the interestingness that urban students show more actions to recycle waste and are better able to organize types of waste. This is due to more complete access to urban recycling infrastructure so that the habit of recycling has been introduced since school. Furthermore, urban areas have recycling facilities and structured regulations in waste management. In line with several research reports, Jošić et al. [55] showed that school programs in urban areas significantly exceed rural areas in the provision of infrastructure and sustainable school programs.

3.4 Challenges

The challenges faced by students are outdoor learning difficulties related to time allocation and learning preparation.

In addition, students also feel that lecturers do not yet have special guidelines for teaching the content of environmental care attitudes in the courses they teach. Furthermore, another challenge is the difficulty of licensing in outdoor learning activities. As mentioned by a male student,"*Most lecturers still teach the environment, such as climate change and environmental conservation, through theories rather than practice in the field. This is probably due to the absence of specific guidelines on how to teach these aspects in practice. So, I feel that lecturers have adequate knowledge and good understanding but have not been able to practice or invite students to be able to commit to environmental care actions*." A female student mentioned that habitual activities are needed to demonstrate commitment. "*Lecturers often provide informative videos that can change attitudes. However, not all students can commit to the video. Interesting and routine activities are needed so that environmental conservation becomes a habit*." Another challenge identified is that outdoor learning requires extensive preparation, as outlined in the interview results with female students, "*Preparing for outdoor learning is a challenge in the licensing field. We as students see that outdoor learning requires a longer preparation time than indoor learning because it involves various parties*."

The findings show that there are challenges in implementing outdoor studies. The findings identify that the implementation of outdoor studies requires more time. Similar things are supported by research [56] which states that more flexible time management is needed in implementing outdoor learning. Furthermore, another challenge is the lack of structured guidelines for teachers. The research findings support the findings of prior studies [57, 58] which stated that there is a need for teacher education and training that bridges pedagogical abilities, such as creating an innovative environmental learning ecosystem. As with the research results [59, 60] state that teacher education and training are needed to improve the quality of environmental learning.

4 Conclusion and Implications

Outdoor learning has an effect on pro-environmental behavior. There are key findings related to the perception and influence of outdoor learning. Students show pro-environmental behavior at a moderate level. The findings show that students' attitudes towards saving energy before outdoor learning were in the good category. However, when viewed from the commitment, especially in providing financial contributions, it still needs improvement. Efforts to improve pro-environmental behavior are carried out through outdoor learning interventions. The results of the study showed that there was a significant increase in all indicators of students' pro-environmental behavior with a large effect. This shows the success of outdoor learning in improving pro-environmental behavior, especially in mobility actions such as choosing environmentally friendly transportation. The results of the gender difference analysis did not show any significant differences in students' pro-environmental behavior. However, when viewed from the differences in the areas of origin of students, students from rural areas showed better pro-environmental behavior than urban students. This is most likely due to the greater exposure of students from rural areas to the natural environment. However, when viewed from the aspect of recycling activities, students from urban areas tend to be superior. This is due to the completeness of recycling facilities and the emergence of environmental learning curriculum in schools in urban areas. Although in practice outdoor learning has succeeded in increasing pro-environmental behavior, in practice it still encounters various challenges. The main challenges faced include limited time allocation, limited facilities, and lack of teacher readiness in implementing outdoor learning. Therefore, school support and policies are needed to integrate outdoor learning into the curriculum to form a generation that has an attitude of environmental sustainability. On the policy side, systemic support is needed to integrate outdoor learning as part of the obligation to teach environmental education. The government can collaborate with educational institutions in the preparation of national guidelines and implementation guidelines for outdoor studies within universities. For outdoor learning to have a real impact on the environment, a network of community partnerships and time flexibility is needed.

This study can be one of the references in efforts to increase pro-environmental behavior in students so that it is necessary to integrate outdoor learning into the curriculum. Outdoor learning supports contextual learning to support outdoor learning, supporting skills and policies are needed. The unique findings of this study on the differences in gender and location of the students' homes, so that they can be explored more deeply. The findings of this study can be extended to other geographical areas that have different social and ecological contexts. However, the replication requires adjustments and adaptations related to learning content that is in accordance with local wisdom, learning approaches used, and support from local policies.

Based on the research findings, it is recommended to develop teacher skills in outdoor learning and develop outdoor learning modules that focus on real actions. Furthermore, it is recommended to provide supporting facilities for outdoor learning to support the effectiveness of learning. Furthermore, a deeper exploration is needed of other factors that influence students' perceptions of pro-environmental behavior.

5 Limitations and Suggestions

Although this study makes an important contribution to understanding the impact of outdoor learning, there are some limitations to the study. This study examines the perception and impact of outdoor learning. This research was only conducted in three universities in western Indonesia. These three universities are still relatively homogeneous to

generalize according to the geographical context of western Indonesia. However, this location is not necessarily able to generalize to the rest of Indonesia, let alone the international context. This is due to the possibility of differences in cultural backgrounds, levels of ecological awareness, and learning styles of students in eastern Indonesia. Similarly, other countries with different education systems, infrastructure quality, and environmental values may produce different research findings. Furthermore, the study involved students of a limited age group (around 18–23 years old), who generally have cognitive abilities, access to digital information, and a relatively high level of autonomy in daily decision-making. These characteristics are different from school students, teachers, or adults outside the institution. Therefore, generalization of the findings to other age groups needs to be done with caution and requires replication of the study in different segments of the population. Furthermore, in terms of research design using a one-group pretest and post-test approach, although the design was able to see changes after the outdoor learning intervention, the research design has not been able to fully isolate the effect of the intervention and possible external factors such as peer influence, social environment outside the intervention and others. In addition, this study did not explore mediating variables that influence pro-environmental behavior. The limitations of this study open up opportunities to conduct more complex research approaches.

Thus, suggestions for future research are to conduct similar research in areas with other geographical and social characteristics, for example conducting comparative research between Western Indonesia and Eastern Indonesia or other countries. In addition, it is necessary to further explore research involving more uniform age groups. In addition, a more robust research design is needed such as involving a control group to strengthen the validation of the findings and consider other variables that may influence the factors that influence pro-environmental behavior.

Author Contributions

Conceptualization, R.M.S; methodology, R.R.; formal analysis, R.M.S, R.R, and T.M.S.; investigation, K.P.H; writing—original draft preparation, R.M.S.; writing—review and editing, T.M.S and R.R.; visualization, F.U; supervision, K.P.H.; project administration, F.U. All authors have read and agreed to the published version of the manuscript.

Funding

This research was made possible by the Research and Innovation for Advanced Indonesia (RIIM) Program research grant funded by the National Research and Innovation Agency (BRIN) and the Indonesia Endowment Fund for Education Agency (LPDP) with contract numbers 177/IV/KS/11/2023 and 25/UN54. 6/KS/2023, and also Universitas Samudra for helping the research to be carried out.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Acknowledgements

All authors are very grateful for the assistance provided by BRIN, LPDP, and Universitas Samudra. Furthermore, the authors are very grateful to the geography education students who have greatly assisted in the implementation of this research.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] P. Straßer, "Environmental issues hidden in medical education: What are the effects on students' environmental awareness and knowledge?" *Z. Evid. Fortbild. Qual. Gesundheitsw.*, vol. 174, pp. 97–102, 2022. https://doi.org/10.1016/j.zefq.2022.07.006

[2] V. Kumar, S. K. Choudhary, and R. Singh, "Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review," *Soc. Sci. Hum. Open*, vol. 9, p. 100765, 2024. https://doi.org/10.1016/j.ssaho.2023.100765

[3] D. Rakhmawati, M. Murdiono, S. P. Kawuryan, and R. Hidayah, "The influence of ecological citizenship teaching materials to improve environmental care: A meta-analysis," *Int. J. Environ. Impacts*, vol. 8, no. 1, pp. 91–102, 2025. https://doi.org/10.18280/ijei.080110

[4] N. Ahmad, L. Youjin, S. Žiković, and Z. Belyaeva, "The effects of technological innovation on sustainable development and environmental degradation: Evidence from China," *Technol. Soc.*, vol. 72, p. 102184, 2023. https://doi.org/10.1016/j.techsoc.2022.102184

[5] N. M. Suki, N. M. Suki, A. Sharif, S. Afshan, and K. Jermsittiparsert, "The role of technology innovation and renewable energy in reducing environmental degradation in Malaysia: A step towards sustainable environment," *Renew. Energy*, vol. 182, pp. 245–253, 2022. https://doi.org/10.1016/j.renene.2021.10.007

[6] C. The, A. Marín-Marín, F. J. Liu, and C. C. Yeh, "The influence of competency-based VR learning materials on students' problem-solving behavioral intentions—Taking environmental issues in junior high schools as an example," *Sustain.*, vol. 14, no. 23, p. 16036, 2022. https://doi.org/10.3390/su142316036

[7] G. Malandrakis, P. Koulouri, and K. Velempini, "Assessing the role of environmental education practices towards the attainment of the 2030 sustainable development goals," *Sustainability*, vol. 17, no. 5, p. 2043, 2025. https://doi.org/10.3390/su17052043

[8] T. M. Baierl and F. X. Bogner, "Cognitive learning about forests: The key role of environmental attitude," *Int. J. Sci. Educ.*, vol. 47, no. 3, pp. 358–378, 2024. https://doi.org/10.1080/09500693.2024.2323917

[9] M. J. Mohamed and A. M. Omar, "The role of climate change research and habitat restoration campaigns in promoting sustainable environmental conservation in higher education," *Int. J. Des. Nat. Ecodyn.*, vol. 20, no. 2, pp. 453–460, 2025. https://doi.org/10.18280/ijdne.200223

[10] S. Suarlin and M. I. Ali, "The effect of environmental education learning on students at university," *Int. J. Environ. Eng. Educ.*, vol. 2, no. 3, pp. 49–56, 2020. https://doi.org/10.55151/ijeedu.v2i3.39

[11] Sumarmi, M. Aliman, and T. Mutia, "The effect of digital eco-learning in student worksheet flipbook to environmental project literacy and pedagogic competency," *J. Technol. Sci. Educ.*, vol. 11, no. 2, pp. 357–370, 2021. https://doi.org/10.3926/jotse.1175

[12] D. A. R. Robledo and M. S. Prudente, "'A virtual fieldtrip': Effects of Google Earth learning activities (GELA) on students' environmental awareness and environmental attitudes: Effects of Google Earth learning activities on students' environmental values," in *Proceedings of the 2022 13th International Conference on E-Education, E-Business, E-Management, and E-Learning*, New York, NY, USA, 2022, pp. 1–8. https://doi.org/10.1145/3514262.3514293

[13] R. Amini, Nurhastuti, T. Wijanarko, Y. Fitria, and Y. Erita, "Learning of outdoor-based environmental education to improve environmental literacy of prospective teachers," *AIP Conf. Proc.*, vol. 3220, no. 1, p. 020032, 2024. https://doi.org/10.1063/5.0235375

[14] L. Yang, A. B. Ibrahim, W. Tan, and Y. Wang, "Exploring the synergy: Outdoor adventure education, self-efficacy, and learning motivation within the framework of outcome-based education," *Salud, Ciencia y Tecnología - Ser. Conf.*, vol. 4, pp. 1286–1286, 2025. https://doi.org/10.56294/sctconf20251286

[15] J. Mann, T. Gray, and S. Truong, "Does growth in the outdoors stay in the outdoors? The impact of an extended residential and outdoor learning experience on student motivation, engagement and 21st century capabilities," *Front. Psychol.*, vol. 14, p. 1102610, 2023. https://doi.org/10.3389/fpsyg.2023.1102610

[16] W. T. Fang, A. Hassan, and B. A. LePage, "Outdoor education," in *The Living Environmental Education*. Springer, Singapore, 2023, pp. 229–260. https://doi.org/10.1007/978-981-19-4234-1_8

[17] J. Quay, T. Gray, G. Thomas, S. Allen-Craig, M. Asfeldt, S. Andkjaer, S. Beames, M. Cosgriff, J. Dyment, P. Higgins, and et al., "What future's for outdoor and environmental education in a world that has contended with COVID-19?" *J. Outdoor Environ. Educ.*, vol. 23, no. 2, pp. 93–117, 2020. https://doi.org/10.1007/s42322-020-00059-2

[18] N. Cotič, J. Plazar, A. I. Starčič, and D. Zuljan, "The effect of outdoor lessons in natural sciences on students' knowledge, through tablets and experiential learning," *J. Baltic Sci. Educ.*, vol. 19, no. 5, pp. 747–763, 2020. https://doi.org/10.33225/jbse/20.19.747

[19] M. El-Aasar, Z. Shafik, and D. Abou Bakr, "Outdoor learning environment as a teaching tool for integrating education for sustainable development in kindergarten, Egypt," *Ain Shams Eng. J.*, vol. 15, no. 4, p. 102629, 2024. https://doi.org/10.1016/j.asej.2024.102629

[20] S. Z. Alshehri, "Exploring students' pro-environmental knowledge and behaviour perceptions: A mixed methods investigation," *J. Turk. Sci. Educ.*, vol. 21, no. 3, pp. 389–409, 2024. https://doi.org/10.36681/tused.2024.021

[21] Z. Zeng, W. Zhong, and S. Naz, "Can environmental knowledge and risk perception make a difference? The role of environmental concern and pro-environmental behavior in fostering sustainable consumption behavior," *Sustainability*, vol. 15, no. 6, p. 4791, 2023. https://doi.org/10.3390/su15064791

[22] S. Akhtar, K. U. Khan, F. Atlas, and M. Irfan, "Stimulating student's pro-environmental behavior in higher education institutions: An ability–motivation–opportunity perspective," *Environ. Dev. Sustain.*, vol. 24, no. 3, pp. 4128–4149, 2022. https://doi.org/10.1007/s10668-021-01609-4

[23] S. Berger and A. M. Wyss, "Measuring pro-environmental behavior using the carbon emission task," *J. Environ. Psychol.*, vol. 75, p. 101613, 2021. https://doi.org/10.1016/j.jenvp.2021.101613

[24] I. Ahn and S. H. Kim, "Measuring the motivation: A scale for positive consequences in pro-environmental behavior," *Sustainability*, vol. 16, no. 1, p. 250, 2023. https://doi.org/10.3390/su16010250

[25] L. Granda, P. J. Moya-Fernández, R. M. Soriano-Miras, and F. González-Gómez, "Pro-environmental behaviour in household water use. A gender perspective," *Sustain. Water Resour. Manag.*, vol. 10, no. 2, pp. 1–11, 2024. https://doi.org/10.1007/s40899-023-01027-6

[26] C. Xiao and D. Hong, "Gender differences in environmental behaviors among the Chinese public: Model of mediation and moderation," *Environ. Behav.*, vol. 50, no. 9, pp. 975–996, 2018. https://doi.org/10.1177/0013916517723126

[27] S. Cao, D. Wu, L. Liu, S. Li, and S. Zhang, "Decoding the effect of demographic factors on environmental health based on city-level $PM_{2.5}$ pollution in China," *J. Environ. Manag.*, vol. 349, p. 119380, 2024. https://doi.org/10.1016/j.jenvman.2023.119380

[28] V. L. Plano Clark, N. Anderson, J. A. Wertz, Y. Zhou, K. Schumacher, and C. Miaskowski, "Conceptualizing longitudinal mixed methods designs: A methodological review of health sciences research," *J. Mixed Methods Res.*, vol. 9, no. 4, pp. 297–319, 2015. https://doi.org/10.1177/1558689814543563

[29] M. Hirose and J. W. Creswell, "Applying core quality criteria of mixed methods research to an empirical study," *J. Mixed Methods Res.*, vol. 17, no. 1, pp. 12–28, 2023. https://doi.org/10.1177/15586898221086346

[30] F. G. Kaiser, "GEB-50: General ecological behavior scale," *Leibniz-Institut für Psychologie (ZPID) (Hrsg.)*, 2020. https://doi.org/10.23668/PSYCHARCHIVES.3453

[31] S. M. Geiger, M. Geiger, and O. Wilhelm, "Environment-specific vs. general knowledge and their role in pro-environmental behavior," *Front. Psychol.*, vol. 10, pp. 1–12, 2019. https://doi.org/10.3389/fpsyg.2019.00718

[32] A. M. Nieva, "Personality traits as predictors of pro-environmental behavior: Evidence from the Philippines," *Bedan Res. J.*, vol. 9, no. 1, pp. 145–173, 2024. https://doi.org/10.58870/berj.v9i1.68

[33] R. del C. L. Severino and J. P. S. Domínguez, "Validation of the ecological behavior scale in Mexican university students," *Psicol.: Teor. Pesqui.*, vol. 40, p. e40502, 2024. https://doi.org/10.1590/0102.3772e40502.en

[34] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, 2006. https://doi.org/10.1191/1478088706qp063oa

[35] V. Kroker and F. Lange, "Financial and prosocial incentives promote pro-environmental behavior in a consequential laboratory task," *J. Environ. Psychol.*, vol. 96, p. 102331, 2024. https://doi.org/10.1016/j.jenvp.2024.102331

[36] M. Ling and L. Xu, "How and when financial incentives crowd out pro-environmental motivation: A longitudinal quasi-experimental study," *J. Environ. Psychol.*, vol. 78, p. 101715, 2021. https://doi.org/10.1016/j.jenvp.2021.101715

[37] C. M. L. Mackay and M. T. Schmitt, "Do people who feel connected to nature do more to protect it? a meta-analysis," *J. Environ. Psychol.*, vol. 65, p. 101323, 2019. https://doi.org/10.1016/j.jenvp.2019.101323

[38] C. D. Trott, "Children's constructive climate change engagement: Empowering awareness, agency, and action," *Environ. Educ. Res.*, vol. 26, no. 4, pp. 532–554, 2020. https://doi.org/10.1080/13504622.2019.1675594

[39] A. Husin, Y. K. Nengsih, and H. Helmi, "The impact of environmental education on intergenerational knowledge transfer and household behavior: A quantitative study from Palembang," *Int. J. Environ. Impacts*, vol. 8, no. 1, pp. 33–40, 2025. https://doi.org/10.18280/ijei.080104

[40] S. I. S. Syed-Abdullah, "Why travel far to learn? A study of environmental behaviour change experience of residential outdoor environmental education participants," *J. Advent. Educ. Outdoor Learn.*, vol. 24, no. 4, pp. 591–611, 2023. https://doi.org/10.1080/14729679.2023.2170437

[41] T. J. Mateer, B. D. Taff, C. A. Hunt, P. Allison, and E. Will, "Understanding emerging adult identity development through work at a residential outdoor environmental education program: An application of social practice theory," *Environ. Educ. Res.*, vol. 27, no. 9, pp. 1383–1400, 2021. https://doi.org/10.1080/13504622.2021.1927994

[42] W. Simms and M. C. Shanahan, "Qualitatively recognizing the dimensions of student environmental identity development within the classroom context," *J. Res. Sci. Teach.*, vol. 61, no. 1, pp. 3–37, 2024. https://doi.org/10.1002/tea.21863

[43] M. R. Fan, N. H. Tran, L. H. P. Nguyen, and C. F. Huang, "Effects of outdoor education on elementary school students' perception of scientific literacy and learning motivation," *Eur. J. Educ. Res.*, vol. 13, no. 3, pp. 1353–1363, 2024. https://doi.org/10.12973/eu-jer.13.3.1353

[44] C. H. Hsu, "Outdoor environmental education as a nature-based solution for "education" and "environment": A new conceptual framework and its pilot application in a coastal community case study in Taiwan," *J. Coast. Conserv.*, vol. 29, no. 1, pp. 1–15, 2025. https://doi.org/10.1007/s11852-025-01099-w

[45] S. L. Flecke, J. Huber, M. Kirchler, and R. Schwaiger, "Nature experiences and pro-environmental behavior: Evidence from a randomized controlled trial," *J. Environ. Psychol.*, vol. 99, p. 102383, 2024. https://doi.org/10.1016/j.jenvp.2024.102383

[46] W. Xia and L. M. W. Li, "Societal gender role beliefs moderate the pattern of gender differences in public

and private-sphere pro-environmental behaviors," *J. Environ. Psychol.*, vol. 92, p. 102158, 2023. https://doi.org/10.1016/j.jenvp.2023.102158

[47] E. Alfaro, C. Marin, and S. A. Useche, "Mind the gap! Gender differences in the predictors of public transport usage intention," *Transp. Res. Part F: Traffic Psychol. Behav.*, vol. 111, pp. 453–466, 2025. https://doi.org/10.1016/j.trf.2025.03.013

[48] L. Stofejová, B. Gavurová, S. Kral, R. Bacik, and R. Fedorko, "Gender differences in environmentally sustainable consumer behaviour in the context of electronic commerce," *Montenegrin J. Econ.*, vol. 21, no. 1, pp. 169–178, 2025. https://doi.org/10.14254/1800-5845/2025.21-1.13

[49] G. Gaard, "Ecofeminism revisited: Rejecting essentialism and re-placing species in a material feminist environmentalism," *Feminist Formations*, vol. 23, no. 2, pp. 26–53, 2011. https://doi.org/10.1353/ff.2011.0017

[50] A. Mertens, M. von Krause, A. Denk, and T. Heitz, "Gender differences in eating behavior and environmental attitudes—The mediating role of the dark triad," *Personal. Individ. Differ.*, vol. 168, p. 110359, 2021. https://doi.org/10.1016/j.paid.2020.110359

[51] M. Hilbert, "Digital technology and social change: The digital transformation of society from a historical perspective," *Dialogues Clin. Neurosci.*, vol. 22, no. 2, pp. 189–194, 2020. https://doi.org/10.31887/dcns.2020.22.2/mhilbert

[52] D. Padmaningrum, F. Julian Santosa, Widiyanto, R. Roro Ilma Kusuma Wardani, D. Purwanto, and R. Fathinah Maharani, "Local knowledge in forest management: A case study in Java forest, Indonesia," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 1317, no. 1, p. 012015, 2024. https://doi.org/10.1088/1755-1315/1317/1/012015

[53] A. Abas, A. Aziz, and A. Awang, "A systematic review on the local wisdom of indigenous people in nature conservation," *Sustainability*, vol. 14, no. 6, p. 3415, 2022. https://doi.org/10.3390/su14063415

[54] M. F. Popescu, B. C. Chiripuci, A. Orîndaru, M. Constantin, and A. Scrieciu, "Fostering sustainable development through shifting toward rural areas and digitalization—The case of Romanian universities," *Sustainability*, vol. 12, no. 10, p. 4020, 2020. https://doi.org/10.3390/su12104020

[55] S. Jošić, B. Japelj Pavešić, N. Gutvajn, and M. Rožman, "Scaffolding the learning in rural and urban schools: Similarities and differences," in *Dinaric Perspectives on TIMSS 2019: Teaching and Learning Mathematics and Science in South-Eastern Europe*. Cham: Springer International Publishing, 2022, vol. 13, pp. 213–239. https://doi.org/10.1007/978-3-030-85802-5_10

[56] T. Mutia, L. Y. Irawan, Sumarmi, R. Meilitasari, and R. R. Prasad, "The relationship between the adiwiyata program based on environmental activities and students' environmental care attitudes in supporting green schools," *Int. J. Sustain. Dev. Plan.*, vol. 20, no. 1, pp. 25–31, 2025. https://doi.org/10.18280/ijsdp.200103

[57] E. M. Embacher and W. Smidt, "Associations between teachers' professional competencies and the quality of interactions and relationships in preschool: Findings from Austria," *Front. Psychol.*, vol. 14, p. 1222369, 2023. https://doi.org/10.3389/fpsyg.2023.1222369

[58] Mahsun, Sumarmi, S. Utaya, B. Handoyo, and N. A. Wibowo, "Enhancing environmental awareness: Evaluating the impact of project-based hybrid learning on critical thinking for high school students," *Int. J. Environ. Impacts*, vol. 8, no. 1, pp. 123–135, 2025. https://doi.org/10.18280/ijei.080113

[59] L. Fernandes, F. Peixoto, M. J. Gouveia, J. C. Silva, and M. Wosnitza, "Fostering teachers' resilience and well-being through professional learning: Effects from a training programme," *Aust. Educ. Res.*, vol. 46, no. 4, pp. 681–698, 2019. https://doi.org/10.1007/s13384-019-00344-0

[60] T. Pozo-Rico, R. Gilar-Corbí, A. Izquierdo, and J. L. Castejón, "Teacher training can make a difference: Tools to overcome the impact of COVID-19 on primary schools. An experimental study," *Int. J. Environ. Res. Public Health*, vol. 17, no. 22, p. 8633, 2020. https://doi.org/10.3390/ijerph17228633