

Environmental Literacy among Pre-Service Teachers Towards Integrating Green Technology into the Classroom

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Abstract. Alarming environmental degradation urges educators to be well-trained with the essential knowledge and skills to integrate green technology into school curricula. This study investigated the level of awareness and extent of practices of pre-service teachers regarding green technology. The study also determined the relationship between awareness and practices. The respondents of this study were undergraduate education students of Bulacan Agricultural State College. Data were analyzed using mean and standard deviation, Spearman's rank correlation, and thematic analysis. The study explored how the respondents perceive and potentially integrate green technology into their future classrooms by employing sequential explanatory mixed-methods design. Findings revealed that most respondents are moderately aware of green technology and its benefits in addressing environmental issues. Results also indicate a high overall extent of practices of pre-service teachers regarding green technology. Furthermore, the correlation ($r_s = 0.465$) shows that the level of awareness and extent of practice in green technology positively correlated to a moderate degree. The relationship was statistically significant with a p-value lesser than 0.05 significance level, $t(8.832)$, $p = 0.000$. The insights and conceptualizations of the pre-service teachers regarding green technology strengthened the quantitative data. Their practices reflect green and sustainable living, and they hold exciting insights into the benefits of green technology in mitigating climate change. The findings proposed a strategic environmental management plan to enhance pre-service teachers' capacity to leverage green technology. Thus, it is essential to implement a carefully developed strategic ecological management plan to raise students' dedication, passion, and commitment toward environmental sustainability.

Keywords: Climate change; Environmental education; Green technology; Pre-Service teachers; Sustainable practices.

1.0 Introduction

The Philippines, being highly vulnerable to climate change impacts, frequently experiences severe natural disasters, exacerbating environmental degradation and emphasizing the urgent need for sustainable practices (Peñalba, 2021). In line with the global environmental goals, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) advocates for integrating education for sustainable development (SDG4), aiming to raise awareness of environmental issues through education (Gonzaga, 2016). As essential information agents, teachers are pivotal in fostering environmental awareness and action among future generations. However, pre-service teachers need more training in ecological literacy and green technology (Bahar et al., 2008; Özsoy, 2012). This gap limits their ability to effectively educate students on critical environmental issues like climate change and sustainable living.

Integrating green technology into educational curricula can equip students with the tools to mitigate environmental damage and adapt to sustainable practices. However, studies show that while teachers recognize the importance of environmental education, many still need to be equipped with the requisite knowledge and training to implement concepts effectively (Li et al., 2023). Furthermore, pre-service teacher training programs often inadequately address this practical and conceptual integration of green technologies into teaching practices (Álvarez-García et al., 2015). This gap is significant because educational institutions promote environmental consciousness and sustainable practices.

Recent studies reveal several barriers to green technology integration in education, including financial constraints, limited environmental knowledge, and skepticism toward sustainable practices (Lay et al., 2013). While universities are gradually adopting sustainable technologies, integration remains inconsistent, and efforts are often fragmented, as mentioned (Ateeu et al., 2024). Despite progress in implementing green technologies in higher education, a comprehensive, systematic approach to environmental literacy within teacher education is still insufficient (Sadh, 2019). This study addresses these gaps by assessing pre-service teachers' current awareness and practices regarding green technology to enhance their capacity to lead sustainable education initiatives.

This research explores the environmental literacy of pre-service teachers, focusing on their awareness and practices related to green technology. By identifying future educators' current knowledge levels and practices, this study sought to bridge gaps in environmental education and support the integration of green practices within classroom settings. Ultimately, the findings aim to inform a strategic environmental management plan designed to empower pre-service teachers with the skills and motivation to promote ecological sustainability effectively.

2.0 Methodology

2.1 Research Design

The study employed a sequential explanatory mixed-methods design, a two-phase research approach. In the first phase, quantitative data were collected and analyzed to explore the pre-service teachers' level of awareness and extent of practices regarding green technology. In the second phase, qualitative data were gathered through open-ended questions to further explain and elaborate on the quantitative findings. A two-part process of data collection and analysis is included in a sequential explanatory mixed-methods design, as described by Wipulanusat et al. (2020), with the qualitative phase building on the quantitative findings. Qualitative data provided a more comprehensive understanding of the research problem using the initial quantitative results. The quantitative phase allowed for the measurement and analysis of the pre-service teachers' awareness and practices, while the qualitative phase offered an in-depth exploration of their conceptualizations, insights, and perspectives regarding green technology. The sequential explanatory design was deemed appropriate for this study as it enabled the researcher to establish the baseline quantitative data and then use the qualitative findings to explain the numerical results in greater depth. This design also allowed for the development of a more comprehensive strategic environmental plan based on the integrative findings from both phases of the research.

2.2 Research Locale

The study occurred in Bulacan Agricultural State College, San Ildefonso, Province of Bulacan, Central Luzon, Philippines. This college is a lone agricultural higher education institution and a home for the province's financially challenged but deserving students. It was founded in 1952 as Plaridel Community Agricultural High School and later renamed Bulacan National Agricultural High School (BNAHS) in 1953. The school was renamed Bulacan National Agricultural School (BuNAS) in 1959 and became a state college in 1998 under Republic Act No. 8548, solidifying its significant role in agricultural education.

2.3 Research Participants

The researcher collected the data from 80 pre-service teachers. Purposive sampling is the sampling technique utilized in the study where the target respondents were not forced to participate and considered their right to withdraw. According to Oliver (2013), purposive sampling is a form of non-probability sampling in which decisions concerning the individuals to be included in the sample could be treated by the researcher based on a variety of criteria, which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research. Pre-service teachers were chosen as the study's respondents because they would be the

next generation of teachers and must be well-trained in environmental ed that they can use to teach environmental education to their future learners regardless of the subject they will handle.

2.4 Research Instrument

A structured questionnaire from the study “Level of Knowledge, Comprehension, and Attitude of Rural Communities on Green Technology” by Chik et al. (2017) was adopted to gather data from respondents. The researcher sent an email to ask permission from the authors to adopt their instrument. The researcher made certain modifications to make it suitable in the study context, such as some statements or questions were transferred to which category they were most appropriate. The survey instrument consisted of three parts. Part I inquired about the socio-demographic profile of the respondents in terms of sex, age, and year level. Likert scale response options such as level of awareness and frequency, adopted from Vagias (2006), were the appropriate measures for the statements that respondents may choose from to rate their responses to the indicated evaluative questions. Part II consisted of statements on the level of awareness regarding green technology. Five-point Likert scale techniques of ‘5 – Extremely aware’, ‘4 – Moderately aware’, ‘3 – Somewhat aware’, ‘2 – Slightly aware’, and ‘1 – Not at all aware’ were used to score the items. Part III consisted of items on pre-service teachers' extent of practice of green technology. Five-point Likert scale of ‘5 – Always’, ‘4 – Often’, ‘3 – Sometimes’, ‘2 = Rarely’ and ‘1 = Never’ were used. The last part included five open-ended questions to obtain the students' insights about green technology's importance, examples, misconceptions, and how it can help mitigate climate change and integrate it into the curriculum. The researcher organized the questionnaires using Google Forms and created a link the respondents could access. Pre-service teachers were required to open their email accounts for the online survey form. Instruction that explains that all the information the respondents provide is treated with utmost confidentiality as indicated. Responses were automatically recorded by the Google form when the students had completed the survey form completely and submitted their responses correctly.

2.5 Data Gathering Procedure

A research consent form indicating the crucial conditions and considerations to the respondents has been provided for ethical purposes. A survey questionnaire was disseminated through Google Forms to gather the data. They were required to open their email accounts to access the Google form through a link. They were also required to answer all the questions with red asterisk (*) marks from the Google Form. Clear instructions for each part of the online survey form were included regarding how the Data Privacy Act protected the respondents and how they would complete the questionnaire. During the data gathering, pre-service teachers submitted their responses, and for transparency purposes, the researcher could view each respondent's responses. The online survey form was open for two weeks, allowing the respondents ample time to complete the questionnaire. On average, it took the respondents around 15-20 minutes to answer the entire survey, which included both the Likert-scale items and the open-ended questions.

2.6 Data Analysis

Since the study used a sequential explanatory quantitative and qualitative research method, descriptive statistics such as mean and standard deviation were used to analyze data for the respondent's level of awareness and extent of practice in green technology. Spearman's rank correlation was employed to determine the relationship between the respondents' awareness and practice of green technology. Subsequently, the open-ended responses were analyzed through a Thematic Analysis to explain the implications and conceptualizations made by the pre-service teachers regarding Green Technology. The data gathering and analysis were conducted sequentially, with the quantitative phase preceding the qualitative phase. This convergent approach allowed the researcher to better understand the research problem by integrating the quantitative and qualitative findings to generate more comprehensive insights and recommendations. The method of Braun and Clarke (2006) involving six phases of thematic analysis was applied to generate findings. These phases are the following: 1. Familiarizing oneself with the data where the researcher read and re-read the open-ended responses to become thoroughly familiar with the content; 2. Generating initial codes in which the significant statements and phrases were identified and coded to capture key ideas and concepts; 3. Searching for themes where the coded data was collated, the researcher began searching for broader themes that could encompass the various codes; 4. Reviewing themes where the identified themes were reviewed and refined to ensure they accurately represented the data; 5. The themes were clearly defined and named to reflect their essence and distinguish them from one another, and 6. Producing the report was the last step, and the final themes were used to generate a detailed analysis and interpretation of the

qualitative findings. Furthermore, the recommendations for the strategic environmental management plan were presented in a tabular form based on the findings.

2.7 Ethical Considerations

This research study followed ethical guidelines. The researcher kept the data gathered confidential and raw data were stored on a USB device to protect the privacy of each respondent. After the data gathering, the summarized data from the collected data were preserved for the results and discussion.

3.0 Results and Discussion

3.1 Awareness of Green Technology

Table 1 shows the respondents' awareness of green technology, including their perspective on its importance, utilization and implementation, and impact on reducing environmental problems.

Table 1. Pre-service teachers' level of awareness in green technology

Parameters	Mean	SD	Description
1. I am aware of the importance of green technology to the environment.	4.19	0.90	Moderately aware
2. I am aware that green technology can guarantee a healthy and pleasing environment	4.08	0.92	Moderately aware
3. I am aware of the technology of green consumption to society, the country, and the environment.	3.86	0.88	Moderately aware
4. I know that green technology can reduce Greenhouse Gas emissions (GRH).	4.04	0.91	Moderately aware
5. I know that using green technology can save energy and non-renewable natural resources.	4.25	0.82	Extremely aware
6. I know that using green technology can reduce the negative impact of human activity.	4.10	0.84	Moderately aware
7. I am aware of the types of green technology products or equipment.	3.50	0.84	Moderately aware
8. I am aware of the government's implementation of the green technology campaign.	3.60	0.87	Moderately aware
9. I am aware that human activities have a lot of adverse effects on the environment.	4.43	0.94	Extremely aware
10. I know that 'Green Building' and 'Go Green' are linked to green technology.	3.90	0.98	Moderately aware
11. I am aware that green technology will have a positive impact on future generations.	4.26	0.91	Extremely aware
12. I know the meaning of the energy-saving sticker attached to electrical appliances.	3.91	0.96	Moderately aware
13. I am aware that green technology can promote renewable energy use.	4.05	0.87	Moderately aware
Overall Mean	4.01	0.89	Moderately aware

The overall computed mean for the respondents' awareness level of green technology was 4.01 with a standard deviation of 0.89 and can be interpreted as "Moderately aware." This result implies that most pre-service teachers are moderately aware of the positive impacts of green technology as a strategy to control the emergence of different environmental concerns and issues. This most likely conformed to the study of Mustapha and Nashir (2019) on the Awareness of Green Technology among Engineering Technology Students. They found that the students have a positive attitude toward green technology and strongly agreed that it is crucial because it could enhance their quality of life.

The highest computed mean for the level of awareness of green technology was item number 9, with a mean of 4.43 and a standard deviation of 0.94, and can be verbally described as "Strongly Agree." This suggests that the pre-service teachers know that human activities have a lot of adverse effects or consequences on the environment. Human activities such as burning fossil fuels, mining, deforestation, illegal fishing, industrialization, and using different technologies are known causes of global warming and the greenhouse effect that eventually leads to climate change. Even though educating people on strategies like green technology will not be enough, pre-service teachers must still be able to address environmental issues efficiently so that students can have empathy and love for their surroundings. This is followed by item 11 ($M=4.26$, $SD=0.91$), in which pre-service teachers strongly agreed with the statement, "I am aware that green technology will have a positive impact on future generations." This means that being aware of green technology would probably orient the community to a more sustainable way of utilizing natural resources from the environment.

Pre-service teachers believed that green technology may be one of the best approaches to promote education for sustainable development. Preserving the future life of the coming generation is a simple description to understand sustainability. Chik *et al.* (2017) also claimed that development, industry, agriculture, forestry, and other human activities have contributed significantly to global warming, climate change, and other natural calamities. Furthermore, with a lack of concern and a less responsible attitude toward environmental maintenance and

preservation, it is complex that situations with a more significant negative influence on the environment, including the quality of human life, are also affected (Ahmad, 2013).

The lowest mean for the awareness level construct about green technology was item 7 ($M=3.50$, $SD=0.84$), which can be described as "Agree." The respondents agreed, "I am aware of the types of green technology products or equipment." This implies that pre-service teachers agreed that they had encountered the types of green technology products or equipment. With this, they can put it into day-to-day practice and even conduct research studies about green technology, further promoting this environmental strategy for the benefit of the people and especially for the recovery of nature. The second lowest recorded mean was item 8 ($M=3.60$, $SD=0.87$), which can be interpreted as "Agree." It can be indicated that the respondents agreed with the statement, "I know the government has implemented the green technology campaign."

Although it is just on the awareness level, it is advantageous for the pre-service teachers to have already encountered the Philippine environmental laws and policies implemented for many years. However, the problem is that there is a lack of evidence that Filipinos strictly and widely obey these laws. It can still be shared that the lack of discipline and disobedience results in different environmental destructions because statutes are said to be followed only at the beginning by setting politics and corruption aside as major problems of the country. Ali et al. (2019) suggested that one of the things that motivates individuals to become more aware of green technology is government policy and regulation. To achieve the strategic aim of green technology, the government also focuses on all the growth and principles of moving toward a nation that prioritizes environmental health. Furthermore, Butt et al. (2018) claimed that political challenges impact the outcome for the Green since political power comes from government rules.

3.2 Practice of Green Technology

Table 2 presents the respondents' green technology practices in terms of the control of the use of paper and plastics, minimizing the activities that cause carbon dioxide emissions, and the practice of reducing, reusing, and recycling.

Table 2. Pre-service teachers' extent of practice of green technology

Parameters	Mean	SD	Description
1. I reuse the unprinted part of the paper for other uses.	3.96	0.91	Often
2. I bring my container when buying food.	3.34	1.09	Sometimes
3. I use organic materials to reduce chemicals in my daily life.	3.60	0.85	Often
4. I bring a reusable water bottle.	4.19	1.07	Often
5. I buy items that are recyclable or made from recycled materials.	3.75	0.89	Often
6. I stopped buying CFC spray because it destroys the ozone layer.	3.76	1.06	Often
7. I separate the waste into paper, plastic, bottles, and cans for recycling purposes.	3.80	0.99	Often
8. I practice recycling at home and hostel.	3.73	1.02	Often
9. I always use green technology products both at home and outdoors.	3.58	0.88	Often
10. I reduce the use of air conditioning at home.	3.78	1.26	Often
Overall Mean	3.81	0.89	Often

The overall mean for this construct was 3.81 with a standard deviation of 0.89, which can be interpreted as "Often" for the respondents. The result suggests that the pre-service teachers often engage in activities regarding the use of green technology. This is an indication that they have already experienced simple practices for engaging in the use of green technology. Therefore, green technology is not new to many because it is just a modified approach to maintaining a well-sustained environment. In the survey conducted by Anusuya and Hashima (2022), it was found that practices related to green technology among Vocational college students are high. Equally, Da Silva (2015) observed favorable attitudes, or high scores, for green technology practices, such as high involvement in environmental activities and using green technology in day-to-day tasks.

Moreover, an additional plausible interpretation of the results may be that they stem from the collective influence of numerous individuals or a population achieving little improvements in their environmental impact, resulting in a marginal development in the environmental impact as a whole (Perrault & Clark, 2018). Different studies also indicated that practices relating to green technology are high (Mustapha & Nashir, 2019; Perrault & Clark, 2018; Salas-Zapata et al., 2018; Musa et al., 2015). On the other hand, some studies negate the findings, reiterating negative or below-satisfactory level practices on green technology (Anusuya & Hashima, 2022; Ahmad et al., 2020;

Hussin & Hafit, 2018). Students' inconvenience is said to be the cause for the low level of green technology practices. The idea that educational organizations like schools should be able to help modify students' environment to influence their behavior is increasingly encouraged. (Perrault & Clark, 2018).

The highest mean computed was item number 4 ($M=4.19$, $SD=1.07$), which can be described as "Often." This means that the pre-service teachers often bring a reusable water bottle. Many people can relate to it as getting a tumbler somewhere has become a trend to reduce waste. Essentially, it is becoming a good practice in the classroom setting or even outdoors the "bring your own tumbler" policy that limits the students and others to use bottled water and plastic cups that are just additional to the waste pollution. The aim of green technology may be to promote more sustainable practices and develop good habits that lead to zero-plastic usage. The second highest mean was item number 1 ($M=3.96$, $SD=0.91$), and verbally describes "Often." This implies that the pre-service teachers often reuse the unprinted part of the paper for other uses, which is an example of being resourceful or economical.

Indeed, the sources of paper used in schools and many offices are the trees from the forest. One cannot imagine how costly it is when a tree is cut just to make papers to be used in the office to print stuff. Another sustainable practice is reusing the back of printed papers to save trees from the forest because they are essential for the ecological balance and for us to breathe. In the same fashion, the findings of Goulgouti et al. (2019) revealed that three out of every four pre-service teachers use paper as a draft, and more than half use plastic and paper bags more often or regularly. Furthermore, more than half of prospective teachers are willing to recycle batteries (56%), plastic, glass, and paper (52%), but only about 46% recycle electric and electronic gadgets.

The lowest mean obtained was item number 2 ($M=3.34$, $SD=1.09$), which can be verbally described as "Sometimes." This explains that the respondents can sometimes bring their containers when buying food. This may be because some students have their own packed lunch while some prefer to eat lunch at the school canteen or take out foods covered by styrofoam with plastic spoon and fork. As role models, teachers may encourage their students to start (even in a gradual phase) shifting into a more sustainable way of living. The second highest mean computed was item number 9 ($M=3.58$, $SD=0.88$), which verbally describes "Often." This suggests that respondents often say, "I always use green technology products both at home and outdoors." With this, the pre-service teachers may be devoted to green technology products if they can regularly use eco-friendly products. However, this is quite challenging as it depends on the availability of the resources and the quality outcomes it provides. Climate change has progressively become more serious, and teaching people about applicable practices or hacks to reduce the consequences is never too late. It is about time for educators, scientists, and leaders to extensively use green technology for the public and let environmental laws and policies take effect for a more extended period. Gonzaga (2016) emphasizes that college students practice green energy, green building, and green chemistry to a low extent. However, it was also mentioned that consumers are growing increasingly mindful of the significance of environmental destruction, which makes them want to buy eco-friendly goods and services and support companies that prioritize ecological practices.

More recently, Yusof et al. (2023) expounded that environmental pollution persists even after several responsible parties have launched ecological education and awareness efforts through social media, books, and other forms of information. Therefore, to contribute to environmental conservation, a persistent effort to raise public awareness of green technology and efficient energy resource management has to be launched, especially among students. For students to practice environmental sustainability and understand its significance, it is also necessary to highlight the necessity of behaviors like conserving water and energy and adhering to the 3R principle.

3.3 Relationship between Awareness about and Practice of Green Technology

Table 3. Correlation between pre-service teachers' level of awareness and extent of practice in green technology

r_s-value	t-value	p-value	Relationship
0.465	8.832	<0.000	Significant

*Correlation, r_s , is significant at $p < 0.05$ level.

The result of Spearman's rank correlation ($r_s = 0.465$) shows that the pre-service teachers' level of awareness and extent of practice in green technology have a positive correlation to a moderate degree. The relationship was reported to be statistically significant (Table 4) with a p-value lesser than 0.05 alpha level of significance, t (8.832),

$p=0.000$. This means that as the awareness of the pre-service teachers increases, their practices in green technology are, to a reasonable extent, indicating. Environmental consciousness is linked to a desire for sustainability, which further leads to participation in movements or initiatives on climate action or environmental protection, as stated in Sustainable Development Goal (SDG) 13.

This finding is similar to the report made by Gonzaga (2016), in which she found a moderate level of awareness but low practice in green technology among college education students. Meanwhile, other studies indicate high attitudes and actions toward sustainability (Sunthonkanokpong & Murphy, 2019). In addition, Lualhati et al. (2024) discussed that environmental law awareness positively correlates with green household practices. Relatively, Ridwan et al. (2021) added that sustainability awareness is generally high among pre-service teachers, but practice may lag. Recommendations for addressing the gap between awareness and practice include creating holistic programs integrating green technology concepts in tertiary education (Gonzaga, 2016) and holding seminars on sustainability and green practices (Lualhati et al., 2024). These initiatives aim to enhance environmental consciousness and promote sustainable living among future educators.

3.4 Qualitative Analysis

Table 4 presents the qualitative analysis of students' responses to the open-ended question, "*In your opinion, how important is Green Technology to solve environmental problems?*" that elaborates on the importance of green technology in terms of climate change mitigation through *minimizing the carbon footprint* that causes global warming and *promoting sustainable solutions* to conserve environment allowing everyone to contribute to global carbon emissions from continuous industrial activities and urbanization. Green technology can be a sustainable solution that aims to provide alternative options for people to become part of the solution rather than part of the problem.

Table 4. Qualitative analysis of students' responses in interview guide question 1

Central Theme (s)	Themes Clusters	Formulated Meanings
Climate Change Mitigation	Minimizing human's carbon footprint	Findings suggest that the emergence of green technology can help solve environmental problems, including carbon emissions in the atmosphere that cause global warming due to human anthropogenic impacts. This implies that individual carbon footprints increase as the human population continuously grows, leading to more challenging climate conditions. Green technology can be an alternative solution to prevent the release of harmful chemicals from industrial destructive activities by shifting to the use of renewable sources of energy that promote conservation over harm.
	Promoting sustainable solutions	
Promote Environmental Sustainability	Conservation of Natural Resources	This means that green technology paves the way for conserving natural resources to provide life for future generations. Specific environmental imbalances are inevitable due to human's ever-changing needs and demands, especially from natural resources. Still, this green technology initiative can teach the community to practice conservation efforts for ecological sustainability. Green technology allows one to appreciate the importance of active participation in climate actions.

Meanwhile, the findings also revealed that green technology promotes environmental sustainability by initiating the conservation of natural resources efforts and ensuring abundant life for the next and future generations. It takes much encouragement to convince people to participate in environmentalism, but instilling self-discipline in younger generations is still possible, even though it is very challenging nowadays. Several studies underscored the importance of green technology in mitigating climate change and promoting environmental sustainability among students. According to Suryawanshi (2018), higher education institutions (HEIs) must embrace green ICT practices, whereas Kadiyono *et al.* (2019) suggest that introducing green technology can increase students' knowledge of environmental issues. With this, some authors address how education shapes students' attitudes and behaviors toward the environment. Bashirun (2023) suggests that green concepts can be incorporated into learning outcomes. On the other hand, Cernicova-Bucă (2023) proposed that students must be prepared to act as

sustainability promoters. Collectively, these studies emphasize the potential impact of green technology to engage and empower students in addressing the pressing issues of climate change and the need for sustainable development.

Table 5 presents the qualitative analysis of students' responses to the question, "*How does GreenTech help fight climate change?*" highlighting that patronizing green consumerism, lessening the carbon footprint, and starting sustainable practices at home are among how one can use green technology to fight climate change. Green consumerism allows one to discover the benefits of being *open to buying eco-friendly products*. It is much like buying products more likely to come from raw materials to improve environmental conditions. Green technology can also *lessen the carbon footprint* by making alternative and sustainable choices when using natural resources for food supply and commercial and industrial purposes, among others. When one consumes a tree, it must be replaced with ten more trees. In a more practical sense, a simple conservation activity at home can lessen the impact of climate change. People need to control their *household activities that harm nature's conditions* by considering basic sustainable practices, no matter how small these are.

Table 5. Qualitative analysis of students' responses in interview guide question 2

Central Theme (s)	Themes Clusters	Formulated Meanings
Renewable sources of energy as a counter to climate change	Solar panels, Windmills, and geothermal sources of energy	Results suggest that renewable sources of energy such as solar panels, windmills, and geothermal forms of energy are part of GreenTech initiatives that allow for energy conservation practices by not compromising or relying too much on coals, fuel, and natural gases, which are non-renewable sources and contribute mainly on the emission of baron in the atmosphere. This may also prevent people from experiencing insufficient reserves or low power supply, leading to power outages.
Zero non-biodegradable wastes	Discouraging the use of plastics	GreenTech is about the product and its meaningful environmental principle, which encourages everyone to participate in climate actions. Influencing others to use eco-bags instead of plastic is a challenge to reducing waste pollution.
Climate-smart methods in agriculture and different industries	Sustainable farming and industrial techniques can help to prevent harmful gas emissions that cause climate change.	This implies that more ongoing innovations in agriculture, industry, and other fields ensure profits while promoting sustainability. It is good that these advanced green technologies are mainly invented to monitor our climatic conditions and minimize the huge impact of environmental problems, such as the greenhouse effect and global warming, which have further caused climate change.

This conforms to the studies of Kumar (2022) and Fatemi *et al.* (2022), who both emphasize the potential of renewable energy sources such as solar, wind, and biomass to lower fossil fuel consumption and environmental pollution in agriculture. Faucher (2006) specified that incorporating renewable systems on farms is advantageous, mainly when manure is used to produce biogas. It was further elaborated that solar-powered technology, which includes photovoltaic modules and energy-efficient pumping systems, plays a crucial role in sustainable agriculture (Dhonde, 2022). These studies highlighted how crucial green technology is to combat climate change and advancing sustainable development.

Table 6 presents the qualitative analysis of students' responses to the question, "*How does GreenTech help fight climate change?*" highlighting that patronizing green consumerism, lessening the carbon footprint, and starting sustainable practices at home are among how one can use green technology to fight climate change. Green consumerism allows one to discover the benefits of being *open to buying eco-friendly products*. It is much like buying products more likely to come from raw materials to improve environmental conditions. Using green technology can also *lessen the carbon footprint* by making alternative and sustainable choices when using natural resources for food supply and commercial and industrial purposes, among others. When one consumes a tree, it must be replaced with ten more trees. In a more practical sense, a simple conservation activity at home can lessen the impact of climate change. People need to control *household activities that harm nature's conditions* by considering basic sustainable practices, no matter how small they are.

Table 6. Qualitative analysis of students' responses in interview guide question 3

Central Theme (s)	Themes Clusters	Formulated Meanings
Green consumerism	Openness to using eco-friendly products.	One practical way to practice green technology is to buy eco-friendly products rather than patronizing those that are destructive to the environment. GreenTech may influence others to shift to sustainable ways and show discipline over the growing human abuse of natural resources.
Lessening carbon footprint	It reduces carbon emissions, greenhouse gases, and other harmful chemicals.	Green technology can lessen the harmful emissions of CO ₂ and other greenhouse gases caused by various human activities. As this occurs, extreme weather conditions can improve, resulting in a healthy environment.
Starting sustainable activities at home	Lessen household activities that contribute to climate change	It indicates that green practices may always begin at home by simply avoiding dumping plastics and harmful chemicals associated with the minimal use of air conditioners, refrigerators, and other home appliances that emit CO ₂ .

Research reveals that there is now an increase in green consumerism that is driven by a desire to combat climate (Roser-Renouf *et al.*, 2016). The positive impact of environmental knowledge, education, and social norms on green purchasing behavior supports this trend (Lin & Niu, 2018). It is further emphasized that through mitigation and adaptation strategies, green technology may be considered a significant component in countering climate change (Olaleru *et al.*, 2021). In addition, communication plays a pivotal role in strengthening attitudes regarding the ability of consumer action to promote green consumption (Roser-Renouf *et al.*, 2016). These results address the role that green technology and consumerism may help mitigate environmental challenges leading to climate change.

Furthermore, studies on sustainable living and green consumerism suggest examining the highly consumed natural resources (Barr, 2011). Experts must look at the complex environment because although small initiatives in households may help to boost the more significant initiatives from people, global environmental issues must automatically be addressed (Holden, 2004). Utilities that promote the automated use of renewable energy to drive sustainable consumption can be encouraged by default regulations (Hale, 2018). These collective efforts start with the behavioral changes and self-discipline of the individuals in the household and outside, which can lessen the carbon footprints regarding energy use, transportation, and waste management (Marchi *et al.*, 2021).

Table 7. Qualitative analysis of students' responses in interview guide question 4

Central Theme (s)	Themes Clusters	Formulated Meanings
Green technology is not economical	It is not affordable to everyone and is less efficient.	Findings elaborate that one of the misconceptions of the respondents is that green technology is not so practical and not cost-efficient. To cite a few applications, using solar panels can help many households save money on their electric bills while preserving the availability of non-renewable resources.
It promotes convenience over sustainability.	GreenTech is no different from the material things we use.	Green technology does not emphasize whether the product is sustainable, but it is mainly done for business purposes or to earn money. In simple words, GreenTech is just a marketing strategy. However, it cannot be denied that it is a green act, much like maximizing the utilization of materials while constructively benefitting the environment rather than destroying it.
Everything is renewable	The ignorance, lack of knowledge, and interest of the people lead them to believe that everything is renewable.	One of the root causes of a misconception of Green technology is people's lack of knowledge and interest in the environment. Discipline and empathy must be imparted to people to prevent environmental abuse, leading them to think that everything can be replenished. However, non-renewable resources are becoming more limited due to destructive human activities.

Table 7 presents the qualitative analysis of students' responses to the question, "What are the misconceptions you have personally encountered about GreenTech among your fellow students and in your community?" emphasizing that some misconceptions that emerge about GreenTech include its cost inefficiency, its function in the market, and the overconsumption of the food, water, and other natural resources. While some advanced climate-smart technology *costs too much to be afforded by someone*, Green Technology promotes eco-friendly products and services.

It significantly offers some positive economic impacts to the public. Some green products are expensive, and some are affordable, but if one could imagine how much they help save energy and conserve resources, it would become a worthy investment to save the Earth. Although green technology may seem to advocate environmentalism too much, it is *not raised for business purposes*. It is more than just a product being sold in the market. As a counter, it is more than just a technology aiming to provide a more significant space for sustainable development. Another misconception raised was the *lack of people's empathy* towards the environment. The sense of sustainability can be lost when an individual exerts no effort or shows no respect for the environment. Destructive human abuse must be stopped right before all the natural resources and life fade.

In support of the above findings, Leckie (2000) has identified certain common misconceptions regarding green technology, one of which is the ignorance of the practicality of renewable energy sources. The misconception of "green technology" itself worsens this, as noted by Allenby (2000), who advocates concentrating on high-quality technology that considers environmental problems. Lesser (2010) clarifies that green technology can save the economy by delving deeper into the financial side. Matatiele and Gulumian (2016) added a word of warning, highlighting the necessity to consider the risks and hazards that could be present with green technologies, especially in developing nations. All of these studies emphasize the need for a deeper understanding of the implications of green technology.

Table 8 presents the qualitative analysis of pre-service teachers' responses to the question, "*How do you think Green Technology can be integrated into different science disciplines apart from just environmental science?*" indicating that GreenTech can be integrated into the school and the local community of the students. Teachers can use *Green Integration* through an interdisciplinary approach to other areas involving environmentally sustainable development. Schools can urge students to initiate eco-literacy activities that allow them to learn the basic concepts of green technology aside from including it in the lessons in environmental science, Araling Panlipunan, and ESP, among others. On the other hand, Green Technology could be integrated across the science discipline through intradisciplinary methods that enrich the students' community and cultural values and holistic environmental development. However, sometimes, it is a matter of the teacher's creativity when one can integrate green concepts into their subject matter.

Table 8. Qualitative analysis of students' responses in interview guide question 5

Central Theme (s)	Themes Clusters	Formulated Meanings
Green Integration	A holistic approach towards promoting eco-friendly initiatives. GreenTech can be applied to TLE, ESP, and Values or any subject through teachers' creative mindset. Student-led environmental stewardship initiatives Studying renewable sources of energy.	Green technology can be integrated across different subject areas. The result suggests that students can learn GreenTech by relating to various environmental issues locally and globally in Social Sciences, acquiring the practical skill in creating eco-friendly handicrafts in Arts or TLE, and its principles of sustainability and efficiency that can be studied in applied disciplines like Agriculture, Fisheries, Medicine, among others. Hence, it develops students' capability to initiate environmentalism and advocate for climate resiliency.
Sustainable Spectrum	Types of Energy Sources, Green Chemistry, and Genetics are some topics that GreenTech can apply to various science disciplines.	In an intradisciplinary sense, GreenTech can be easily applied across different branches of Science like Physics, Chemistry, and Biology, especially when talking about the Law of Thermodynamics, the Law of Conservation of Mass, energetics, developing Genetically Modified Organisms (GMOs) for developing climate-resilient crops for better yield as well Artificial Intelligences (AIs) that monitor weather changes and assist scientists in analyzing data for accurate interpretation of calamities such as extreme weather conditions, earthquakes, tsunamis, and other natural disasters.

Timmer *et al.* (2018) provided evidence in the field of chemistry regarding the successful integration of green technology into various subjects and disciplines by taking a holistic approach. This strategy gradually introduces green chemistry ideas into already-existing courses to encourage sustainable reasoning and thinking. Cai (2010)

lends even more support to this, stressing the role computers play in building a sustainable future and arguing for the inclusion of sustainability in undergraduate computing education. Kivimaa and Mickwitz (2006) stress the importance of incorporating environmental policy and green chemistry concepts into the curriculum to prepare future scientists and advance ecological preservation. These examples highlight how green technology integration may be applied to various topics and specialties.

3.5 Proposed Strategic Environmental Management Plan

The proposed environmental management plan was crafted based on the Likert scale and open-ended questions interview results. The activities included were based on the least weighted means obtained from the survey.

Table 9. List of proposed activities

Specific Objective/s	Title of the Activity	Person/s Involved	Duration	Expected Output
To apply arts and develop students' creativity by appreciating the beauty and dominance of biodiversity inside the campus.	Project Eco-CAPTURE: A Photography and Video-Making Contest	Students Teaching staffs Non-teaching staffs	Monthly (every 2 nd semester)	Photographs and videos featuring the biodiversity inside the campus Feedback from viewers via Facebook
To lessen the use of plastics on campus,	➤ Project "BRING YOUR C-U-P ➤ Conserve biodiversity ➤ Uphold environmentalism ➤ Protect the Earth A seminar on the disadvantages of using plastics that cause pollution	Teachers Students Resource Persons Parents	November	Attendance sheet of participants, evaluation report, student and parents' manifesto
To produce eco-friendly products and items that can help students make an additional source of income while promoting ecological sustainability.	Project "Eco-PROdukto GAD-vocacy" This training will be initiated by the Gender and Development Office (GAD) and other student organizations to teach students sustainable practices by creating or innovating inclusive and sustainable products/items that can be a source of additional income for the students and will support their financial needs. This will also include the participation of men and women in producing Eco-materials.	GAD Director GAD Focal Person Training Specialist Student Organizations Teachers Student General Public	October-December and May-June	Innovative eco-friendly products include bamboo pens, reusable straws, and coffee cups.
To encourage students to love their local products. To encourage everyone, especially the young, to be the agent of change for the environment in their local communities.	Project "Go Green BASCIans": A series of environmental activities that will engage students in community and campus clean-up drives, tree planting activities, gardening, and other environmental advocacy campaigns.	Teachers Students College Community	August-December and January to June	Attendance sheet of participants, evaluation report, pamphlets

4.0 Conclusion

The study found that the overall level of awareness of the pre-service teachers on green technology is Moderately Aware. This suggests that most respondents are reasonably aware of green technology's benefits and positive impacts in addressing various environmental concerns and issues. However, pre-service teachers still need to have a deeper understanding of the detrimental effects that human activities such as burning fossil fuels, industrialization, and using different technologies could have on the environment. It is crucial to equip pre-service teachers with a more comprehensive knowledge of environmental problems and the practical ways to mitigate them, as they will serve as role models and educators for future generations.

In terms of the overall extent of green technology practices, the pre-service teachers Often engage in activities related to the use of green technology. This indicates that they have already incorporated some sustainable practices into their daily lives, such as reusing paper, bringing reusable water bottles, and separating wastes for recycling. These findings suggest that the pre-service teachers have a reasonably firm foundation in applying green technology principles, which can be further leveraged and expanded upon in their future classrooms.

The study also revealed a significant positive correlation between the pre-service teachers' level of awareness and the extent of their practices regarding green technology. This emphasizes the importance of increasing environmental awareness and knowledge, as it can lead to more sustainable behaviors and integrating green technology into various aspects of life, including educational settings. By equipping pre-service teachers with the necessary knowledge, skills, and mindset, they can better incorporate green technology into their teaching practices and foster environmentally conscious attitudes among their students. The study also proposes a strategic environmental management plan that could guide educational institutions in developing and implementing initiatives to enhance pre-service teachers' capacity to leverage green technology for sustainable development.

However, it is vital to acknowledge the limitations of this study. The research was conducted within a single institution, and the findings may not be generalizable to a broader population of pre-service teachers. Additionally, the study relied on self-reported data, which can be subject to potential biases or inaccuracies. Future studies could explore the perspectives and practices of pre-service teachers across multiple educational institutions, both public and private, to address limitations and further expand the scope of the research. Comparative analyses between different regions or socioeconomic backgrounds may also provide valuable insights into the factors that influence environmental awareness and green technology integration. Furthermore, longitudinal studies tracking the long-term impact of green technology integration on pre-service teachers' practices and their students' environmental behaviors would be a valuable avenue for future research.

This study stresses the pivotal role of pre-service teachers in promoting environmental sustainability and integrating green technology into the classroom. By enhancing their awareness, fostering positive attitudes, and facilitating sustainable practices, pre-service teachers can become catalysts for change, inspiring future generations to embrace a more eco-friendly and sustainable future. The proposed strategic environmental management plan serves as a roadmap for educational institutions to empower pre-service teachers and equip them with the necessary tools and resources to address pressing environmental challenges.

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The author did all the research, from the write-ups to the execution, presentation, and publication process.

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7.0 Conflict of Interests

The author declares no conflict of interest concerning the publication of this paper.

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