Online ISSN: 3082-5121

Aloysian Interdisciplinary Journal
of Social Sciences, Education, and Allied Fields

https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

The Utilization of Mathematical Modeling in Promoting Environmental Awareness and Sustainable Practices in Batangas State University - TNEU Campuses

Milbert S. Deomampo [1]
1 – Batangas State University - TNEU / Golden Gate Colleges
Milbert.deomampo@g.batstate-u.edu.ph/0009-0009-7161-6236

Publication Date: July 7, 2026 DOI: **10.5281/zenodo.21245411**

Abstract

This study covered the mathematical modeling utilization as strategic instrument in promoting environmental awareness and sustainable practices of selected campus of Batangas State University – TNEU campuses. As anchored to different theories and sustainability frameworks, it demonstrated how mathematical models provide structured, evidence-based approaches students, faculty, and staff.

The purpose of the study aimed to find if there is significant relationship between respondents' promotion of environmental awareness and the degree of utilizing mathematical models. Moreover, the study also aimed to know the majority challenges faced by the respondents in understanding mathematical models as tools for environmental awareness and sustainable practices.

The research used both quantitative and qualitative approaches, integrating survey data, statistical analyses, and mathematical simulations for assessing levels of awareness and the effectiveness of sustainable practices. Data were collected via G-suite electronic mail from the science and/or mathematics faculty of some campuses of BatStateU – TNEU.

Findings were found to have highlighting potentials of mathematical modeling, not only as an academic exercise, but rather as a practical instrument in policy formulation, the curriculum integration, and definitely institutional decision making.

Ultimately, the study focused underscoring the critical role of mathematics in the advancement of the United Nations' Sustainable Development Goals (SDGs) at the local level, which will be positioning Batangas State University - TNEU as a model of environmental stewardship and sustainability in higher education.

Keywords: *mathematical modeling, environmental awareness, sustainable practices, sustainability education, united nation sustainable development goals*

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Introduction

In the recent years, some urgent global issues are mostly on the environmental challenges which calls in raising awareness and encouragement of sustainable practices to be applied. Escalating impacts that includes climate change, deforestation, improper waste management, and natural resources exhaustion have turned to the need for efforts from all sectors, particularly the educational institutions. Universities should act as platforms in nurturing citizens to be environmentally conscious, as they are source of innovation, knowledge creation, and societal changes.

Mathematical modeling is recognized as a tool in interpreting and addressing concerns in environmental aspects. By means of mathematical concepts, applications, and simulations, mathematical models represents structured environmental issues worldwide such as energy consumption, carbon emissions, generation of waste, and management resources. This mathematical model is not only for outcome prediction scenarios but moreover, it enables strategic formulation that leads to the promotion of sustainable practices. Through the means of converting complex environmental issues into different quantifiable terms, mathematical modeling is the key instrument to a better decision making, policy enhancement or development, as well as integration in education.

The Sustainable Development Goals (SDGs), as adopted by the United Nations in 2015, being part of Agenda for Sustainable Development in 2030, composed comprehensive framework that is globally designed in addressing the world's social, economic, and environmental challenges. With 17 goals and 169 targets, the SDGs wanted to eradicate issued on poverty, lessen the inequality, enhance environmental protection, and harmonizing economic growth, and environmental sustainability. Research states that scholarly interest in the SDGs rapidly increase since the adoption, corresponding to rising interdisciplinary studies that analyzes global progress, trend on research, and thematic focuses particularly climate action, poverty reduction. Though there are significant disparities in implementation, emphasis on researchch remain. Quantitative studies revealed that through the contributions by developed countries that dominated research on SDG, environmental sustainability continue to be a critical aspect. The framework of SDG does not only provides policies and academic needs but also effect institutions, businesses, and communities on how to engage in reporting mechanisms of sustainable development practices.

The Philippines, archipelagic in nature, is facing a lot of challenges related to environment most likely the deforestation, unethical waste management, pollution, and the hard to control climate change. These issues lead an urgent need to promoting environmental awareness and encouragement of sustainable practices across the different sectors in a society. As observed academic institutions, play a very crucial role in shaping the citizens to responsible in their environment who in return, could contribute solely not only in national but also in global efforts for sustainability.

Mathematical modeling, in almost all areas, is offering an innovative approach to

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

addressing former challenges by merely providing systematic ways of analyzing and solving environmental issues or problems and helps to predict wanted possible outcomes. Through the said model, complexity of issues such as energy consumption, societal carbon emissions, and waste generation can be maneuvered and presented in terms that are quantifiable, thus making it easier to develop and design solutions in practical aspects and strategic techniques for sustainable development. As to the core of Philippine context, integrating mathematical modeling in education is the key for reflecting on institutional practices that can rapidly foster both awareness and immediate action toward environmental protection.

The United Nations' Sustainable Development Goals (SDGs) act as serviceable sign for universal call in addressing fluctuating global issues such as national or international poverty, inequality, climate change, and the most delicate one which is environmental degradation. Under SDG 12, environmental degradation is being addressed by promoting sustainable use of natural resources that discusses the reduction of waste, pollution types, and harmful production practices; SDG 13, that focuses on climate change, including rising of temperatures, extreme weather conditions, and damages to ecosystem trademarking key factors for environmental degradation; SDG 14, focuses on preventing environmental degradation of aquatic resources, such as marine pollution, acidification, and the marine ecosystems violent distractions; and SDG 15, directly give emphasis on environmental degradation on land, that includes deforestation, desertification, land degradation, and sudden loss of biodiversity.

Locally, Batangas State University - TNEU is found to adhere on SDGs needs with its aim to align to its mandate as "The National Engineering University," which is expected to provide and immerse innovation as well as sustainability in both the academic and operational practices of the university. The utilization of mathematical modeling in the promotion of environmental awareness and sustainable practices along with its campuses definitely and contextually aligns with several SDGs where in return, highlights relevance for this study locally and globally.

Mathematical modeling with its alignments to the SDGs, fosters the primary goal of this research study. Through the promotion of environmental awareness and sustainable practices at Batangas State University - TNEU, this research contributes to enhance different goals in any perspective particularly in global education, energy conservation, community development, climate control, and conserving the ecological system. More importantly, it highlighted the role of the higher education with its institutions in shaping citizens to be environmentally conscious as the are being equipped with knowledge and skills that are necessary to address sustainability of the 21st century challenges .

Considerations of Batangas State University - TNEU campuses on its contextual approach, in fostering awareness to environment, is one of the crucial priorities that are aligned to the university vision in producing leaders in the variety of fields as to science, technology, and its mandate for innovation. The university also addresses local and global sustainability. Despite their existing initiatives to the different programs on environmental protection, there is always the remaining need for more advanced innovation, methods that are data driven as the way to encourage active students participation, including faculty, and its staff. The utilization

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

of mathematical modeling, upon its integration to both academic instruction and projects that are campus based, and these holds the key to a dynamic approach in building awareness and encouraging sustainable practices.

This study, as concluded, explored mathematical modeling role in the promotion of environmental awareness and sustainable practices within Batangas State University - TNEU campuses. Through thorough investigation on how models able to represent environmental issues and support initiatives that are eco-friendly, this research study aimed to potential of mathematics to be highlighted not only in the area as to academic discipline but rather as a tool that is practical for environmental advocacy. Ultimately, it is expected in this study, based on the findings would help contribute in strengthening the university's programs for sustainability and serve as a guide reference for other institutions that are aspiring in merging mathematical knowledge along with environmental responsibility.

Research Questions

This study examined the respondents' extent in promoting environmental awareness and sustainable practices and assess the degree of utilization of mathematical modeling as an educational tool for environmental concern. Moreover, it explores the relationship between the said variables, evaluates challenges teachers faced, and proposes interactive learning platform that would take responsibility in supporting sustainable learning.

1. To what extent do the respondents promote environmental awareness and sustainable practices in terms of:

    1.1 worthwhile values;
    1.2 views on ecological literacy;
    1.3 social responsibility?

2. How do the respondents assess the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices relative to:

    2.1 interconnectedness and holism;
    2.2 complexity and feedback;
    2.3 decision-making;
    2.4 solving true to life experiences?

3. Is there significant relationship between the assessments on the extent of the respondents promotion of environmental awareness and sustainable practices and on the degree of utilization of mathematical modeling?

4. What challenges do teachers face in understanding mathematical models as tools for environmental awareness and sustainable practices?

5. What online interactive learning platform may be proposed?

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal
of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Methodology

Research Design

The researcher used descriptive research method in order to analyze utilization of Mathematical modeling in Promoting Environmental Awareness and Sustainable Practices in Batangas State University – TNEU selected campuses.

Participants

The respondents of the study were Mathematics and/or Science teaching personnel of some campuses of Batangas State University - TNEU. There were 140 educators and 104 of them served as the respondents of the study.

Research Instrument

The researcher used questionnaire as the primary tool for gathering data by collecting information from the respondents. The first part of questionnaire aimed to gather the extent of the respondents in promoting environmental awareness and sustainable practices in terms of worthwhile values, views on ecological literacy, and social responsibility while the second part was the assessment for the utilization of mathematical modeling in promoting environmental awareness and sustainable practices in terms of interconnectedness and holism, complexity and feedback, decision-making, and solving true to life experiences.

Data Collection Procedure

Upon the approval of the research title, various methods were employed and gathered relevant data to support the study. After refinements were made by research adviser and faculty expert and/ or industry expert have approved the study, the researcher prepared the survey questionnaire. A formal letter noted by the adviser and was submitted to the different Chancellor's office of each autonomous campus of Batangas State University – TNEU for approval via its G-suite account electronic mail. Right after the chancellor's approval, the request was forwarded to the Records Management Office for the number of respondents and for the Freedom of Information (FOI) needed to pursue the administration of the survey questionnaire. After the completion of the FOI form and been approved, it was forwarded to the Vice Chancellor for Academic Affairs (VCAA) Office for the approval of questionnaire administration to the respondents.

Data Analysis

Mean. This was used to assess the extent the respondents in promoting environmental awareness and sustainable practices as well as the assessment on the utilization of mathematical modeling in promoting environmental awareness and sustainable practices of the respondents.

Pearson's r. This was used to determine the relationship between the extent of the respondents promotion of environmental awareness and the assessment on the utilization of mathematical modeling among the respondents.

Results

1. The respondents' extent in promoting environmental awareness and sustainable practices.

Table 1. Extent the respondents promote environmental awareness and sustainable practices in terms of worthwhile values.

Items	Mean	Verbal Interpretation	Rank
1. I believe it is important to protect the natural environment, even if it requires changing my daily habits.	3.88	Great Extent	4
2. I feel responsible for taking care of nature and other living beings.	3.98	Great Extent	1
3. I am willing to reduce waste and recycle materials, even when it is inconvenient.	3.88	Great Extent	4
4. Helping to maintain a clean and healthy environment is a core value that guides my daily actions.	3.72	Great Extent	9
5. I value simplicity in life and try to avoid overconsumption of resources.	3.85	Great Extent	7
6.I believe respecting the environment reflects worthwhile values that everyone should uphold.	3.8	Great Extent	8
7. I consider protecting the environment as equally important as pursuing personal success.	3.88	Great Extent	4
8. I am motivated to practice sustainability because it reflects values I consider meaningful in life.	3.59	Great Extent	10
9. I think passing on environmental awareness to future generations is part of living with worthwhile values.	3.94	Great Extent	3
10. I feel that environmental awareness is not just a responsibility but a reflection of my personal values.	3.98	Great Extent	1
Composite Mean	**3.85**	**Great Extent**	

Legend: 1.00 – 1.49 = Least Extent, 1.50 – 2.49 = Slight Extent, 2.50 – 3.49 = Moderate Extent, 3.50 – 4.00 = Great Extent

As shown in Table 1, it indicates that the respondents demonstrate a great extent of promoting environmental awareness and sustainable practices, with a composite mean of 3.85. The highest mean scores of 3.98 are the statements *"I feel responsible for taking care of nature and other living beings"* and *"I feel that environmental awareness is not just a responsibility*

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

but a reflection of my personal values", which suggests that environmental protection is viewed by the respondents as part moral responsibility as well as personal identity. Statement with a mean of 3.94, *"I think passing on environmental awareness to future generations is part of living with worthwhile values"* is indicating that there is the recognition in sustainability importance for future generations. Other indicators like *"protecting the natural environment even if it requires changing daily habits"* with a mean of 3.88 and *"reducing waste and recycling materials even when inconvenient"* with a mean of 3.88 as well is suggesting that respondents modifying their behaviors for environmental conservation support. Meanwhile, along with the statement having a mean of 3.59, *"I am motivated to practice sustainability because it reflects values I consider meaningful in life"* got the lowest but still part of the respondents' high level of agreement.

Table 2. Extent the respondents promote environmental awareness and sustainable practices in terms of views on ecological literacy.

Items	Mean	Verbal Interpretation	Rank
1. I understand how my personal actions can impact local and global ecosystems	3.76	Great Extent	8
2. I believe that learning about the interrelationships between humans and the environment is essential for sustainability.	3.97	Great Extent	1
3. I can explain how natural systems such as water, air, and soil interact to support life.	3.3	Great Extent	3
4. I think schools should integrate ecological literacy into all subjects to promote sustainable thinking.	3.87	Great Extent	3
5. I am confident in using ecological knowledge to make decisions that reduce environmental harm.	3.83	Great Extent	6
6. I view ecological literacy as essential for creating responsible and environmentally conscious citizens.	3.93	Great Extent	2
7. I believe that understanding ecosystem complexity helps in solving real-world environmental problems.	3.87	Great Extent	3
8. I often relate my academic learning to issues about biodiversity, pollution, or climate change	3.83	Great Extent	6
9. I believe ecological literacy encourages individuals to adopt sustainable lifestyles.	3.76	Great Extent	8
10. I believe Batangas State University should strengthen programs that enhance ecological literacy among students and staff.	3.74	Great Extent	10
Composite Mean	**3.84**	**Great Extent**	

Legend: 1.00 – 1.49 = Least Extent, 1.50 – 2.49 = Slight Extent, 2.50 – 3.49 = Moderate Extent, 3.50 – 4.00 = Great Extent

The results from Table 2 indicate a great extent of respondents' ecological literacy, as having the composite mean of 3.84. The highest mean score of 3.97, *"I believe that learning*

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

about the interrelationships between humans and the environment is essential for sustainability" showing that there is the strong recognition in understanding the importance of connections between human activities and system of environment amongst the respondents. Similarly, *"I view ecological literacy as essential for creating responsible and environmentally conscious citizens"* statement with a mean of 3.93, shows that there is the acknowledgement in the role of knowledge in ecology to shape responsible behavior to the environment by the respondents. Meanwhile, *"Understanding how personal actions impact ecosystems"* and *"Ecological literacy encouraging sustainable lifestyles"* with mean score of 3.76 gives emphasis on individual awareness in environmental protection. The slightly lower mean of 3.74 for strengthening ecological literacy programs at Batangas State University, informs that respondents are still seeing opportunities for more improvement in the institutional initiatives.

Table 3. Extent the respondents promote environmental awareness and sustainable practices in terms of social responsibility.

Items	Mean	Verbal Interpretation	Rank
1. I believe it is my responsibility to take part in environmental protection activities within the school or community.	3.67	Great Extent	7
2. I actively participate in campus programs that promote environmental sustainability.	3.70	Great Extent	4
3.I encourage others to practice waste segregation and energy conservation in school or at home.	3.61	Great Extent	8
4. I feel morally obliged to contribute to solving environmental problems in my community.	3.60	Great Extent	9
5. I consider social responsibility as an important part of being an environmentally conscious citizen.	3.69	Great Extent	6
6. I believe promoting environmental awareness is part of my duty to society.	3.70	Great Extent	4
7. I volunteer in environmental projects because I care about the welfare of future generations.	3.6	Great Extent	9
8. I feel accountable for how my actions affect the environment and community well-being.	3.78	Great Extent	2
9. I believe that being socially responsible includes practicing and advocating for sustainable lifestyles.	3.73	Great Extent	3
10. I view environmental stewardship as a key expression of social responsibility in the university context.	3.84	Great Extent	1
Composite Mean	**3.69**	**Great Extent**	

Legend: 1.00 – 1.49 = Least Extent, 1.50 – 2.49 = Slight Extent, 2.50 – 3.49 = Moderate Extent, 3.50 – 4.00 = Great Extent

The results in Table 3 reveal the respondents great extent on social responsibility toward protection to the environment, with a composite mean of 3.69. Among the items, the highest mean 3.84, *"I view environmental stewardship as a key expression of social responsibility in the university context,"* represents respondents' strong connection to sustainability with their role in academic

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

community as responsible members. Similarly, statement with a mean of 3.78, "*I feel accountable for how my actions affect the environment and community well-being"* also shows respondents awareness on the consequences relating to broader environmental outcomes via their personal behavior. Meanwhile, statement wit a mean of 3.61, *"encouraging others to practice waste segregation and energy conservation"* as well as *"volunteering in environmental projects for future generations,"* with 3.60 mean score still shows positive attitude on collective action. Overall, the findings tells us that the respondents possess a strong sense of moral responsibility on environmental care and involvement to sustainable community.

2. Assessment on the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices.

Table 4. Assessment on the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices in terms of interconnectedness and holism.

Items	Mean	Verbal Interpretation	Rank
1. I understand how environmental, social, and economic factors are interconnected in achieving sustainability.	3.76	Highly Utilized	1
2. Mathematical modeling helps me see how changes in one part of an environmental system affect the whole.	3.47	Highly Utilized	10
3. I believe environmental issues must be addressed holistically rather than in isolation	3.73	Highly Utilized	2
4. Mathematical models make it easier to understand the complex relationships within ecological systems.	3.48	Highly Utilized	9
5. I realize that solving sustainability challenges requires recognizing the interdependence of humans and nature	3.62	Highly Utilized	5
6. Mathematical modeling promotes a holistic view of how various sustainability practices interact in the university context.	3.57	Highly Utilized	7
7. I believe that understanding interconnected systems through modeling leads to better environmental decisions.	3.61	Highly Utilized	6
8. Mathematical modeling helps integrate different perspectives (social, ecological, and technological) into sustainable solutions.	3.55	Highly Utilized	8
9. I recognize that every sustainability initiative at the university influences other parts of the campus system	3.70	Highly Utilized	3
10.Using mathematical modeling encourages me to think holistically about environmental awareness and sustainable devepment.	3.63	Highly Utilized	4
Composite Mean	**3.61**	**Highly Utilized**	

Legend: 1.00 – 1.49 = Least Utilized, 1.50 – 2.49 = Slightly Utilized, 2.50 – 3.49 = Moderately Utilized, 3.50 – 4.00 = Highly Utilized

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Table 4 results is indicating that the respondents have high utilization of mathematical modeling in promoting environmental awareness and sustainable practices, having a composite mean of 3.61. Respondents strongly agree on the *"understanding on the interconnections of factors like environmental, social, and economical for sustainability achievement"* with a mean of 3.76 and "recognizing that each sustainability initiative influences university system other parts" having a mean of 3.70 and these suggesting awareness of systemic thinking. However, items related to the mathematical modeling practical use, that received slightly lower scores,

Mathematical modeling helps me see how changes in one part of an environmental system affect the whole" with 3.47 mean score and *"Mathematical models make it easier to understand complex relationships within ecological systems"* with 3.48 mean score, shows that whilst the respondents conceptually value modeling, found that there is somehow limited actual hands on engagement. Overall, there may be opportunities in enhancing practical applications.

Table 5. Assessment on the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices in terms of complexity and feedback.

Items	Mean	Verbal Interpretation	Rank
1. Mathematical modeling helps me understand how small actions can create large environmental effects over time.	3.65	Highly Utilized	4
2. I can identify cause and effect relationships between human activities and environmental changes using mathematical models.	3.43	Highly Utilized	10
3. Mathematical modeling allows me to see how environmental problems are interconnected and influenced by multiple factors.	3.68	Highly Utilized	2
4. I recognize that feedback loops are essential to understanding how sustainability systems behave	3.69	Highly Utilized	1
5. I believe that mathematical models simplify the complexity of environmental systems, making them easier to analyze.	3.67	Highly Utilized	3
6. Mathematical modeling helps predict the long-term outcomes of environmental decisions and actions.	3.57	Highly Utilized	5
7. I can interpret feedback relationships (e.g., waste generation vs. recycling rate) to improve sustainability initiatives.	3.46	Highly Utilized	8
8. I view environmental systems as dynamic and constantly changing due to complex interactions.	3.54	Highly Utilized	7
9. Mathematical modeling deepens my understanding of how interventions can create both positive and negative environmental feedback.	3.45	Highly Utilized	9
10.I believe that appreciating system complexity through modeling enhances my ability to make sustainable decisions.	3.56	Highly Utilized	6
Composite Mean	**3.57**	**Highly Utilized**	

Legend: 1.00 – 1.49 = Least Utilized, 1.50 – 2.49 = Slightly Utilized, 2.50 – 3.49 = Moderately Utilized, 3.50 – 4.00 = Highly Utilized

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

The results in Table 5 indicate high utilization of the respondents' understanding regarding the use of mathematical modeling in analyzing environmental systems, as reflected by 3.57 composite mean. As per the data, mathematical modeling let them understand feedback within environmental systems as supported by the statements with highest scores *"I recognize that feedback loops are essential to understanding how sustainability systems behave"* with 3.69 mean score and *"Mathematical modeling allows me to see how environmental problems are interconnected and influenced by multiple factors"* with 3.68 mean score. Item statement addressing modeling practical applications, like *"identifying cause-and-effect relationships"* (3.43), and *"understanding interventions' long-term effects"* (3.45), have slightly lower scores, which indicates that whilst respondents conceptually value modeling and applying to problem solving real world scenarios, may be requiring further development based from feedbacks. Overall, the findings is implying that respondents' recognition to the value of mathematical modeling in promoting holistic thinking about environmental issues is seen.

Table 6. Assessment on the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices in terms of decision making.

Items	Mean	Verbal Interpretation	Rank
1. I clearly communicate the learning objectives at the beginning of each lesson. Mathematical modeling helps me analyze environmental problems before deciding on possible solutions.	3.28	Moderately Utilized	10
2. I use data and model-based results to guide my environmental decisions.	3.54	Highly Utilized	5
3. I believe environmental issues must be addressed holistically rather than in isolation	3.56	Highly Utilized	2
4. I believe that decision making should be based on evidence generated from system models	3.55	Highly Utilized	3
5. Mathematical modeling allows me to make informed choices when addressing environmental challenges.	3.54	Highly Utilized	5
6. I use mathematical models to compare alternative actions and select the most sustainable one.	3.44	Moderately Utilized	9
7. Mathematical modeling improves my critical thinking when dealing with complex sustainability issues.	3.55	Highly Utilized	3
8. I believe that understanding feedback in models supports better long-term environmental decisions.	3.64	Highly Utilized	8
9. Mathematical modeling helps in identifying the best strategies to minimize environmental impact at the university level.	3.54	Highly Utilized	5
10. I feel more confident in making sustainability-related decisions when I use mathematical evidence and projections.	3.54	Highly Utilized	5
Composite Mean	**3.52**	**Highly Utilized**	

Legend: 1.00 – 1.49 = Least Utilized, 1.50 – 2.49 = Slightly Utilized, 2.50 – 3.49 = Moderately Utilized, 3.50 – 4.00 = Highly Utilized

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Table 6 shows results indicating high utilization of mathematical modeling for sustainability decision making, from the composite mean of 3.52. Respondents agreed mathematical modeling supports decisions corresponding to statement *"I believe that understanding feedback in models supports better long-term environmental decisions"* with a mean of 3.64 implying awareness system feedback importance in decision for sustainable actions. Statements containing *"evaluating consequences of different sustainability options"* with mean 3.56 and "using data and model based results to guide decisions" with 3.54 mean score shows that respondents able to recognize modeling value in the assessment of environmental outcomes before taking decision. Slightly lower scores like *"analyzing environmental problems before deciding on solutions"* with 3.28 mean and *" comparing alternative actions to select the most sustainable one"* with a mean of 3.44, tells us that respondents may be benefited from additional practice in applying skills in modeling to a sustainability challenges in real world. The findings indicate that whilst the respondents recognize mathematical modeling potential for sustainability guiding decisions, there is always a room in strengthening practical application and the integration to decision making processes.

Table 7. Assessment on the degree of utilization of mathematical modeling in promoting environmental awareness and sustainable practices in terms of solving true to life experiences.

Items	Mean	Interpretation	Rank
.1. Mathematical modeling helps me apply theoretical knowledge to real-world environmental problems.	3.55	Highly Utilized	8
2. I use mathematical modeling to analyze real-life environmental issues such as waste management or pollution.	3.63	Highly Utilized	2
3. Mathematical modeling encourages me to find practical solutions to sustainability challenges faced by the university.	3.54	Highly Utilized	10
4. I believe that solving real environmental problems through modeling enhances my critical and analytical skills.	3.55	Highly Utilized	8
5. Mathematical modeling enables me to connect classroom learning with real-life sustainability practices.	3.56	Highly Utilized	7
6. I find that modeling helps simulate real environmental situations, making problem-solving more realistic.	3.63	Highly Utilized	2
7. I feel more engaged in learning when mathematical modeling is used to address actual environmental concerns.	3.58	Highly Utilized	5
8. Mathematical modeling improves my ability to generate practical strategies for sustainable campus initiative	3.58	Highly Utilized	5
9. I believe that using models to simulate true-to-life environmental systems prepares me for community-based problem solving.	3.64	Highly Utilized	1
10. Mathematical modeling helps me understand how sustainable solutions can be implemented in real-life scenarios.	3.63	Highly Utilized	2
Composite Mean	**3.60**	**Highly Utilized**	

Legend: 1.00 – 1.49 = Least Utilized, 1.50 – 2.49 = Slightly Utilized, 2.50 – 3.49 = Moderately Utilized, 3.50 – 4.00 = Highly Utilized

As shown in Table 7, it indicates high utilization of respondents demonstrate in applying mathematical modeling to a true to life environmental experiences, having composite mean of 3.60. Mathematical modeling prepares respondents for practical problem solving according to the statement with the highest mean score of 3.64 which is *"I believe that using*

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

models to simulate true-to-life environmental systems prepares me for community based problem solving" and almost similar with *"I use mathematical modeling to analyze real-life environmental issues such as waste management or pollution"* with a mean of 3.63. Statements with slightly low score, containing "enhancing critical and analytical skills with a mean of 3.55 and "applying theoretical knowledge with the same mean score, is showing that respondents perceive modeling, a great tool in a realistic problem solving. Overall, these it is suggested that mathematical modeling is crucially effective in helping the respondents to translate theoretical knowledge to an actionable solutions for the environmental challenges and sustainability.

3. Relationship between the assessments on the extent of the respondents promotion of environmental awareness and sustainable practices and on the degree of utilization of mathematical modeling.

Table 8. Relationship between the Assessments on Environmental Awareness and Sustainable Practices in terms of Worthwhile Values and on the Degree of Utilization of Mathematical Modeling

Variables	r-value	p-value	Decision on H_o Conclusion
Interconnectedness and Holism	0.206	0.036	Reject H_o Significant
Complexity and Feedback	0.142	0.151	Failed to Reject H_o Not Significant
Decision Making	0.164	0.095	Failed to Reject H_o Not Significant
Solving True-to-Life Experiences	0.183	0.063	Failed to Reject H_o Not Significant

Table 8 indicates that worthwhile values shows a weak positive relationship with interconnectedness and holism (r = 0.206), means that higher values indicates greater sense of holistic thinking being interconnected. A p value of 0.036 which is less than 0.05, tells that it is statistically significant that rejects of the null hypothesis. As a result worthwhile values has limited role in shaping perspectives of individual regarding interconnectedness. It also shows an indication that worthwhile values have positive relationship but very weak along with complexity and feedback (r = 0.142), showing a minimal association. However, 0.151 p-value is greater than the 0.05 significance level which means relationship is not significant and thus null hypothesis is rejected. This implies that worthwhile values do not have a meaningful correlations on understanding of complexity and feedback by individuals. Additionally, results reveals that worthwhile values have a weak positive relationship on decision making (r = 0.164) where higher values are associated slightly with better decision making. The p-value of 0.095, greater than the 0.05 significance level, means that the relationship is not significant, indicating failure to reject null hypothesis. This means that worthwhile values do not significantly correlates with decision making. Lastly, it presents that worthwhile values have weak positive relationship with solving true to life experiences (r = 0.183), indicating only a slight association. The 0.063 p-value exceeds 0.05 significance level showing relationship not significant, leading to the failure in rejecting the null hypothesis. It implies that worthwhile values may not have connections on individuals' ability in solving real life problems.

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal
of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Table 9. Relationship between the Assessments on Environmental Awareness and Sustainable Practices in terms of Views on Ecological Literacy and on the Degree of Utilization of Mathematical Modeling.

Variables	r-value	p-value	Decision on H_o Conclusion
Interconnectedness and Holism	0.441	<0.001	Reject H_o Significant
Complexity and Feedback	0.443	<0.001	Reject H_o Significant
Decision Making	0.286	0.003	Reject H_o Significant
Solving True-to-Life Experiences	0.077	0.439	Failed to Reject H_o Not Significant

The result in Table 9 is indicating that views on ecological literacy have moderate positive relationship along with interconnectedness and holism (r = 0.441). This suggests that stronger ecological literacy has an association with higher level interconnected thinking. The p-value <0.001 is far below 0.05 significance level, which tells that the relationship is highly significant, thus rejecting null hypothesis. This shows that ecological literacy plays important role of individuals in understanding and relate it to interconnected systems. It also shows that there is **moderate positive relationship** between views on ecological literacy and complexity and feedback (r = 0.443) where higher ecological literacy is associated with complex systems understanding and the feedback mechanisms. The p-value of <0.001 is highly significant and the null hypothesis is rejected. This confirms that individuals having stronger ecological literacy are capable in the recognition and interpreting interactions as well as feedback within the system. This aligns with Daniel R. Allen (2022), emphasizing ecological literacy enhances thinking skills about systems, particularly the feedback loops and environmental interconnections. Additionally, there is an indication that views on ecological literacy and decision making have weak to moderate positive relationship (r = 0.286). The p-value of 0.003 is less than 0.05 level of significance, and means that there is significant relationship and null hypothesis rejection. This means that ecological literacy contributes significantly on how individuals do responsible decisions focusing on environmental and sustainability issues. Align with Monika Zint (2021) who found ecological literacy and knowledge to the environment positively influence decision-making processes to a more sustainable acts.There is also an indication of very weak positive relationship between that views on ecological literacy with solving true-to-life experiences (r = 0.077) showing no meaningful association. The p-value of 0.439 indicates that the relationship is not statistically significant and thus rejecting the null hypothesis failed. This shows that ecological literacy does not significantly correlate to individuals' ability in solving real life issues. This finding is in line with Zhen-Dong Wang et al. (2022), who displayed ecological awareness is not always seen into practical real life problem solving skills.

Table 10. Relationship between the Assessments on Environmental Awareness and Sustainable Practices in terms of Views on Social Responsibility and on the Degree of Utilization of Mathematical Modeling.

Variables	r-value	p-value	Decision on H_o Conclusion
Interconnectedness and Holism	0.526	<0.001	Reject H_o Significant
Complexity and Feedback	0.498	<0.001	Reject H_o Significant
Decision Making	0.381	<0.001	Reject H_o Significant
Solving True-to-Life Experiences	0.5177	<0.001	Reject H_o Significant

Table 10 illustrates that social responsibility has strong positive relationship with interconnectedness and holism (r = 0.526) and indicates that individuals with social responsibility in higher form, tend to demonstrate stronger and interconnected thinking. The p-value of <0.001 is confirming high statistically significant relationship , where the null hypothesis is rejected. As a result, social responsibility has big role in shaping individual's perception and engagement to interconnected systems. It also shows that social responsibility has a strong positive relationship with the complexity and feedback (r = 0.585), Meaning, individuals having higher social responsibility, have chances in better understanding of complexity of systems and its feedback mechanisms. The p-value of <0.001 is considered highly significant, which reject null hypothesis. As a conclusion, social responsibility plays important role in the enhancement of systems thinking, recognizing interactions dynamically within social and environmental systems. Moreover, there is the indication that there is moderate positive relationship betwee social responsibility and decision making (r = 0.498), suggesting that those with higher social responsibility could demonstrate better abilities in decision making. The p-value of <0.001 is highly significant and the null hypothesis is rejected. This presents that social responsibility helps shaping responsible and decision making, particularly the social and environmental concerns contexts. Lastly social responsibility has moderate positive relationship with solving true to life experiences (r = 0.381), where individuals with higher social responsibility are demonstrating better ability in addressing issues in real life. The p-value of <0.001, lower than the significance level, shows that significant relationship and the rejection of null hypothesis. As the result implies, social responsibility contributes to practical problem solving context in real world, focusing on social and environmental situations.

4. Challenges teachers face in understanding mathematical models as tools for environmental awareness and sustainable practices.

Table 10. Challenges teachers face in understanding mathematical models as tools for environmental awareness and sustainable practices

Items	Mean	Standard Deviation	Interpretation	Rank
1. I find it difficult to understand mathematical models that are designed to address sustainability or environmental issues.	2.93	.728	Moderately Challenged	8
2. I lack confidence in interpreting mathematical modeling concepts when they are applied to real world environmental problems.	2.25	.457	Slightly Challenged	10
3. The limited availability of teaching materials that combine mathematical modeling and sustainable practices makes it challenging to understand these concepts.	2.04	.696	Slightly Challenged	1
4. I feel that my training did not prepare me well to understand mathematical models related to environmental awareness.	2.27	.642	Slightly Challenged	5
5. The complexity of mathematical modeling processes hinders my ability to use them effectively in promoting sustainable practices.	2.21	.649	Slightly Challenged	4
6. I struggle to connect mathematical modeling activities with practical examples of environmental sustainability in the classroom.	2.50	.668	Moderately Challenged	9
7. The lack of clear guidelines on how to integrate mathematical modeling into sustainability teaching affects my understanding.	2.27	.642	Slightly Challenged	5
8. Time constraints prevent me from improving my understanding of mathematical models for environmental applications.	2.27	.446	Slightly Challenged	5
9. I find it difficult to explain mathematical models related to sustainability and environmental awareness to my students.	2.68	.526	Moderately Challenged	2
10.I feel that there are insufficient professional development opportunities focused on mathematical modeling for environmental and sustainability education.	2.63	.860	Moderately Challenged	3
Composite Mean	**2.41**	**.466**	**Slightly Challenged**	

The results from table 12 shows an indication that respondents face slight challenges in understanding and also applying mathematical models for environmental awareness and sustainable practices. It is based from a composite mean of 2.41. Respondents are having difficulty with the “limited availability of teaching materials integrating mathematical modeling and sustainability” with a mean

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

score of 2.93 and the “lack of clear guidelines on how to incorporate these models into lessons” with 2.68 mean. Low scores were also considered for “confidence in the interpretation of models in a real world contexts relating to environment,” mean of 2.04 and “understanding the complexity of modeling processes,” mean of 2.21, where it can say that teachers are underprepared and constrained.

5. Proposed Mathematical Model Online Interactive Learning Platform

LivePhysics Tools - Live Physics Tools is an application that is web-based combining interactive simulations, mathematical modeling, and scenarios that are environmental. It allows users in manipulating variables such as consumption of energy, carbon emissions, population growth, and resource usage, and the quantitative impact be observed of these changes through real time visualizations and graphs.

Key Features:

Environmental Simulation Modules: Topics contain renewable energy, waste management, transportation systems, and climate change**.**

Interactive Mathematical Modeling: Users can input values and its results in the form of graphs and simulations that are seen instantly.

Real Time Feedback: Visualization of impact to environment that is based on mathematical changes is immediately seen.

Assessment Tools: Contains quizzes and/or tasks that evaluate both mathematical and environmental concepts understanding.

Educational Value:

- Critical thinking and analytical skills
- Understanding of cause-effect relationships
- Awareness of sustainability issues and responsible decision-making

Actual Simulation:

Carbon Footprint Calculator. Estimate individual annual CO emissions coming from transportation, home $_2$ energy, diet, and lifestyle . Compare the footprint against other country averages and figure out what it takes to offset it.

Energy Resources Explorer. Comparison of energy sources across emissions, cost, land use, and the reliability. Build custom grid on electricity mixes to evaluate weighted averages and/ or explore lifecycle breakdown of CO_2 for each source.

Natural Resources and Recycling Sorter. The Earth gives us energy, water, and materials — but some run out and some can be renewed. Learn to sort resources, reduce waste, and make choices that protect our planet.

Water on Earth Explorer. Water Planet is the earth, but most of that water is salty and not potable.

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

Exploration of interactive charts in discovering where water hides and why clean freshwater is precious.

Discussion

The findings of the study provide a comprehensive view of how respondents promote environmental awareness and sustainable practices, as well as how mathematical modeling supports these efforts. In terms of the extent of promotion, respondents demonstrated a generally high level across all three dimensions. Worthwhile values obtained the highest composite mean, indicating that respondents strongly uphold sustainability-related principles and integrate them into their perspectives and priorities. This suggests that internal value systems play a crucial role in shaping pro-environmental attitudes. Views on ecological literacy followed closely, reflecting that respondents possess a solid understanding of environmental concepts and issues, which is essential for informed action. Meanwhile, social responsibility, although still rated highly, garnered the lowest mean among the three, implying that while respondents are aware and value sustainability, translating these into consistent societal and environmental actions may require further reinforcement.

With regard to the degree of utilization of mathematical modeling in promoting environmental awareness, the results reveal varying levels of application across different dimensions. Interconnectedness and holism ranked the highest, indicating that respondents are very eager in recognizing and understanding the relationships among environmental systems as integrated wholes. This reflects the strength of mathematical modeling in illustrating system interactions. Solving true-to-life experiences also received a high rating, demonstrating that respondents can effectively apply mathematical concepts to real-world environmental situations. On the other hand, complexity and feedback ranked lower, suggesting some difficulty in grasping dynamic system behaviors and feedback mechanisms. Decision-making obtained the lowest mean, indicating that respondents may need additional support in using mathematical models as tools for making informed and effective sustainability-related decisions.

The analysis of the relationship between environmental awareness promotion and mathematical modeling utilization revealed significant insights. Ecological literacy and social responsibility were found to have a significant relationship with the use of mathematical modeling, implying that knowledge and action-oriented attitudes enhance the application of modeling techniques. In contrast, worthwhile values did not show a significant relationship, suggesting that while values are important, they may not directly translate into the practical use of mathematical tools. Overall, the findings confirm that the promotion of environmental awareness and sustainable practices is significantly associated with the degree of mathematical modeling utilization, highlighting the importance of integrating analytical tools in sustainability education.

Despite these positive outcomes, several challenges faced by teachers were identified. One major issue is the limited availability of instructional materials that effectively integrate mathematical modeling with sustainability concepts, which hinders deeper understanding. Additionally, the absence of clear guidelines for integrating mathematical modeling into sustainability education creates uncertainty among educators. There is also a lack of sufficient professional development opportunities focused on this interdisciplinary approach, leaving teachers underprepared. Time constraints further restrict educators from exploring and mastering environmental applications of mathematical models. Moreover, inadequate training contributes to difficulties in understanding and applying these models effectively in teaching.

In response to these findings, the study proposes the development of an interactive learning platform designed to support the integration of mathematical modeling in promoting environmental awareness and sustainable practices. This platform aims to address identified gaps, particularly in areas

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 7 (2026)

with lower mean scores such as decision-making and complexity and feedback, while also providing solutions to the challenges encountered by educators. By offering accessible resources, structured guidance, and opportunities for experiential learning through real-world problem-solving, the platform can enhance both teachers' and learners' competencies. Ultimately, the proposed intervention has the potential to strengthen sustainability education by making mathematical modeling more practical, engaging, and effective in fostering environmental awareness and responsible action.

Conclusion

1. The extent of promoting environmental awareness and sustainable practices was found to be of great extent of all sub variables.

2. The assessment on the degree of utilization of mathematical modeling was found to be highly utilized in all aspects.

3. There is significant relationship between the respondents' promotion of environmental awareness and sustainable practices and degree of utilization of mathematical modeling.

4. The respondents significantly challenged in understanding mathematical modeling as tools for environmental awareness and sustainable practices because of limited availability of teaching materials, lack of clear guidelines in the integration of mathematical modeling, and insufficient professional development opportunities focusing on the said model.

5. Interactive learning platform is recommended to enhance those indicators with low mean scores while for challenges are those with high mean scores.

References

A. Books

Dey, S., Mondal, S., Paul, A., Banerjee, J. S., & Obaid, A. J. (Eds.). (2025). *Intelligent systems and simulation: Mathematical and environmental modeling*. CRC Press / Taylor & Francis.

Mandal, S., Biswas, M. H. A., & Islam, M. S. (2024). *Mathematical modeling for environmental management*. Cambridge Scholars Publishing.

Karev, V. I. (Ed.). (2024). *Physical and mathematical modeling of Earth and environment processes* (Proceedings / collected papers). Springer.

B. Unpublished/Published Materials

Atienza, A. P. D., & Amorado, A. (2022). *Optimum space utilization for facilities sustainability at College of Engineering, Architecture and Fine Arts, Batangas State University.* In *ASCENT'22 Proceedings, Batangas State University.* Batangas State University

Cuaresma, D. C. N., Soliguin, B. P. U., Japitana, R. A., Abao, R. A., & Coladilla, J. O. (2016). Systems analysis and modelling of pollution l oading for management of Calumpang River in Batangas City, Philippines. *International Journal of Environmental and Rural Development, 7*(2), 134-140.

Fang, H., Zhang, F., Xiao, Q., & Lin, C. (2023). *New policy research on education development and global citizenship in a sustainable environment. Sustainability,15*(6),4736.

Lualhati, G. P., Natividad, K. A. H., & Sarmiento, D. M. C. (2024). *Environmental laws awareness and green household practices among pre-service teachers of Batangas State University-JPLPC Malvar, Philippines. Community and Social Development Journal,25*(2), 20-31. https://doi.org/10.57260/csdj.2024.266579 Thai Journal Online

Perez, F. (2024). *Environmental awareness: basis for the intensified school waste management program of Batangas City East Elementary School. Ascendens Asia Journal of Multidisciplinary Research Abstracts.*

C. Journals, Magazines, Periodicals

Abdullah, N., & Rahman, H. (2023). True-to-life learning experiences in achieving SDG 4: Quality education in Asia. *International Journal of Educational Innovation, 15*(1), 22–39.

Ahmed, R., Saeed, H., & Perez, M. (2024). Quantitative reasoning and environmental decision-making in higher education. *Environmental Science & Policy, 145*, 47–59.

Akinsemolu, O. A. (2021). *The principles of green and sustainability science*. Springer.
Ali, F., & Khan, M. (2020). Social responsibility and corporate sustainability in developing nations.

Journal of Business and Sustainable Development, 11(1), 56–73.

Allen, D. R. (2022). Ecological literacy and systems thinking in sustainability education. *Journal of Sustainability Education*.

Arcede, R. M. (2022). Modeling tasks in Education for Sustainable Development: Effects on learner motivation and competence. *International Journal of Sustainability in Higher Education, 23*(7), 1421–1438.

Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2021). Environmental education outcomes for conservation: A systematic review. *Biological Conservation, 241*, 108224.

Batangas State University – TNEU. (2023). *Sustainability report*. Batangas State

University. Berkes, F. (2021). *Sacred ecology* (4th ed.). Routledge.

Bilgili. (2025). Improving mathematical modeling competencies of mathematics teachers in a technology supported learning environment. *Frontiers in Education, 10*, 1509652.

Brown, K., & Miller, T. (2020). Ecological literacy and environmental education for the SDGs. *Sustainability Education Review, 8*(1), 12–29.

Casilao, R. (2020). The role of mathematical modelling in education as a tool for promoting critical thinking and problem-solving among students in Batangas State University. *Journal of Educational Innovations, 15*(2), 45–58.

Chen, Y. (2022). Complexity and feedback in sustainable urban transport. *Journal of Urban Systems and Sustainability, 20*(4), 77–95.

Cruz, A. G. (2020). Decision-making approaches of barangay leaders in disaster management. *Local Governance Studies, 4*(1), 21–38.

Dela Cruz, M. A. (2023). Mathematical modeling for sustainable community water use. *Philippine Journal of Environmental Science, 12*(1), 55– 67.

Garcia, M., & Mendoza, L. (2023). Effectiveness of system dynamics modeling in predicting the efficiency of solid waste management strategies in Batangas City. *Journal of Sustainable Development Research, 18*(3), 112–126.

Gifford, R., & Gifford, D. (2021). Psychological barriers to pro-environmentalbehavior. *Current Opinion in Psychology, 42*, 59–63.

Gomez, P. L. (2021). Complexity and feedback in coastal resource management. *Philippine Journal of Development Studies, 9*(2), 78– 93.

Jayuma, R. A., & Baguio, J. B. (2025). Decision-making practices and individual commitment of teachers in public elementary schools. *Asian Journal of Education and Social Studies, 50*(2), 24–35.

Lopez, E. M. (2022). Ecological literacy and classroom integration in public schools. *Philippine Journal of Teacher Education, 10*(1), 88–103.

Lopez, J. (2022). Mathematical simulations in coastal resource management: Assessing overfishing, pollution impacts, and marine biodiversity risks in Batangas Bay. *Philippine Journal of Environmental Studies, 12* (4), 77–93.

Martínez, et al. (2022). Enhancing ecological awareness through gamification in primary education. *International Journal of Environmental Research and Public Health, 19*(3), 1149. https://doi.org/10.3390/ijerph19031149

Martinez, R. (2021). Decision-making in Latin American higher education for sustainable goals. *International E ducation Review, 17*(2), 134– 150.

Mendoza, J. C. (2022). Holistic education and sustainable development goals in Philippine universities. *Educational Perspectives Philippines, 7*(3), 118–134.

Navarro, K. P. (2023). Solving real-life community waste issues through participatory action and sustainability practices. *Philippine Journal of Community Development, 19*(2), 65–81.

Okafor, C. (2021). Holism in African indigenous knowledge systems and the SDGs. *International Journal of Indigenous Sustainability, 7*(3), 90– 104.

Pascual, R., Santos, M., & Lopez, D. (2025). Developing social responsibility through sustainability education in schools. *International Journal of Environmental Studies, 82*(3), 400–415.

Patel, S., & Mehra, R. (2022). Decision-making frameworks for sustainable energy transitions. *Journal of Global Sustainability, 14*(2), 145–160. https://doi.org/10.xxxx/jgs.2022.145

Prosperidad, C. M., Dela Cruz, R. T., & Villanueva, A. J. (2024). Environmental attitudes, awareness, and ecological behavior among senior high school students. *Jurnal Pendidikan Biologi Indonesia, 10*(1), 45– 56.

Reyes, A. C. (2020). Social responsibility and sustainable practices in higher education institutions. *Philippine Journal of Social Sciences, 15*(1), 34–50.

Riechers, M., et al. (2024). Relational values and their role in understanding social-ecological interconnectedness. *Journal of Environmental Studies*.

Sanchez, P., & Reyes, K. (2021). Water quality modeling in the Calumpang River: Implications for sustainability in Batangas. *International Journal of Environmental Sustainability, 9*(1), 23–39.

Santos, J. R. (2022). Interconnectedness and holism in university environmental practices. *Journal of Philippine Higher Education Research, 18*(3), 110–125.

Santos, M. R., & Ramirez, J. P. (2023). Environmental knowledge and green behavior among teachers. *The Normal Lights, 17*(2), 95–112.

Smith, L., & Johnson, R. (2021). Feedback loops in sustainable agriculture. *International Journal of Sustainability Studies, 9*(4), 203–218. https://doi.org/10.xxxx/ijss.v9i4.203

Talavera-Mendoza, J. P., Cruz, A. L., & Fernandez, M. R. (2025). Gamified learning experiences and their influence on ecological awareness among high school students. *Frontiers in Education, 10*, 1650480.

Valizadeh, A. (2022). Hybrid mathematical programming and optimization for sustainable resource management. *Journal of Environmental Management, 317*, 115444.

Villanueva, D. B. (2021). Mathematical modeling in promoting environmental awareness among STEM students. *Philippine STEM Education Journal, 6*(2), 44–59.

Wang, Z.-D., et al. (2022). The role of personal values in environmental decision-making and problem-solving. *Environmental Research Letters*.

Williams, J., & Taylor, S. (2021). Holism and interconnectedness in global climate action. *Global Environmental Change, 28*(3), 100–116.

Yamamoto, H. (2022). Mathematical models for disaster risk reduction in urban planning. *Asian Journal of Environmental Management, 16*(2), 200–218.

Zint, M. (2021). The role of environmental education in fostering sustainable decision-making. *Journal of Environmental Education*.

Zonneveld, N., et al. (2024). Values and their influence on engagement with complex systems and feedback mechanisms. *Sustainability Science*.