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Assessing the Environmental Mental Models of Grade School Students in Negros Oriental, Philippines

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Abstract. Understanding how environmental perceptions evolve among younger generations is crucial for developing effective educational curricula and policies that promote sustainable environmental practices. This study explored the ecological perceptions of Grade 7 and Grade 10 students in Negros Oriental using a mental model. A total of 60 students who volunteered were selected for the study, comprising 39 females and 21 males. Among the participants, 30 were in Grade 7 and 30 were in Grade 10. Participants were selected based on their willingness and availability to participate in the study voluntarily. A mixed-method approach combining quantitative and qualitative methods was employed. The Draw-an-Environment Test-Rubric (DAET-R) was used to quantify students' environmental mental models. The DAET-R scores were computed and analyzed using the Mann-Whitney U test to assess statistical differences by grade level. Semi-structured interviews, such as "What comes into your mind when you think about our environment?" and "What do you think constitutes the environment?", were used to examine students' mental representations of the environment qualitatively. The results of this study showed a significant difference in the climate models between Grade 7 and Grade 10 students ($p=0.019$). Students' ecological awareness increases with age, evolving from simple depictions of nature (Grade 7) to more complex themes that incorporate human impact and technology (Grade 10). However, a significant gap in environmental literacy and systems thinking was observed, as no students demonstrated the highest level of conceptual integration. To address this, educational curricula need to prioritize experiential and systems-based learning, fostering critical thinking and ecological responsibility. Students should engage with real-world issues through interdisciplinary approaches. Furthermore, teacher training in experiential methods, technology integration, and hands-on activities is crucial to equip educators with the skills to facilitate this learning effectively.

Keywords: Assessment; DAET-R; Environment; Mental model.

1.0 Introduction

The "Environment" includes all external physical and biological factors influencing human life and economies, encompassing both untouched natural systems (air, water, climate) and human-modified built environments (Zachariou et al., 2020). Rapid economic growth, urbanization, technological advancements, and climate change are driving significant environmental shifts, highlighting the urgent need for environmental protection and sustainable development (Sarwar et al., 2024; Glavina et al., 2025). Environmental education is crucial for achieving this (Vladova, 2023).

Environmental education is a systematic approach to teaching environmental protection and its significance (Vladova, 2023). It shapes students' ecological knowledge and perceptions, influencing their sustainable attitudes, intentions, and behaviors (van de Wetering et al., 2022). This education fosters knowledge about nature, ecological systems, and environmental challenges, promoting an understanding of interconnectedness and encouraging positive environmental actions (Vladova, 2023).

In the Philippines, environmental education is mandated by RA 9512, the National Environmental Awareness and Education Act of 2008, and is integrated into various subjects like science, social studies, and values education (Punzalan, 2020). However, studies show a need to increase environmental awareness and practices among Filipino students. Research indicates a strong link between environmental awareness and perception: improved awareness refines perception, which in turn deepens awareness, leading to greater environmental understanding and appreciation (Escatron et al., 2023). Therefore, for students to engage in good environmental practices, they must first conceptualize what the environment truly is.

Mental models are personal, internal representations of the world. They are constructed by individuals based on their unique life experiences, perceptions, and understandings of the world. Mental models are used to reason and make decisions and can be the basis of individual behaviors (Jones et al., 2011). Analyzing these models helps us understand how people comprehend environmental processes, interrelationships, and cause-and-effect (Ahi & Kahriman-Pamuk, 2021; Çalış & Balci, 2021). Students with stronger mental models tend to exhibit a greater emotional connection and commitment to the environment (Liu & Lin, 2015).

This study used a mental model through the Draw an Environment Test Rubric (DAET-R) to assess the environmental perceptions of Grade 7 and 10 students at Pulangbato National High School in Negros Oriental. This school is located near Mt. Talinis, a natural landscape with hot springs and waterfalls, and is ahomlso site to geothermal power plants (Partlow, 2019).

Understanding these students' views is crucial because Grades 7 and 10 mark key developmental stages in the formation of environmental attitudes. As future environmental stewards, their perceptions are fundamental for creating effective environmental education strategies. The insights from this research can help develop targeted educational interventions to foster environmental literacy and sustainable thinking among young Filipinos, preparing them for future environmental changes.

2.0 Methodology

2.1 Research Design

This study employed qualitative and quantitative research methods within a mixed-methods, sequential, explanatory design. The quantitative part of this study used the Draw an Environment Test Rubric (DAET-R**)** to score students' drawings. Descriptive analyses on the scores were performed, and the relationships between the rubric's sub-dimensions were determined. A phenomenological research design was applied to the qualitative aspect of the study. This approach was chosen to examine students' mental representations of the environment and of concepts that are well known yet not thoroughly comprehended. According to Aydin & Coskun (2011), phenomenology enables researchers to delve into meanings that may not be easily captured, making it ideal for exploring students' views on prospective environmental states. In a mixed-methods sequential explanatory design, the quantitative data were collected first using DAET-R to identify patterns in the students' environmental perceptions. This was followed by a semi-structured interview to understand the reasoning behind these quantitative results. The data collected in this study are all primary.

2.2 Participants and Sampling Technique

The participants were Grade 7 and Grade 10 students from Negros Oriental, Philippines, enrolled in the 2024-2025 academic year. A total of 60 students who volunteered were selected for the study, comprising 39 females and 21 males. Among the participants, 30 were in Grade 7 and 30 were in Grade 10. Participants were selected based on their willingness and availability to participate in the study voluntarily.

2.3 Research Instrument

The primary research tool used was the Draw-and-Environment Test rubric (DAET-R) created by Moseley et al.

(2010) and modified by Çalış & Balci (2021). The Draw an Environment Test Rubric (DAET-R) assesses environmental perceptions across four subdimensions: humans, biotic, abiotic, and artificial environments. Each subdimension is scored from 0 to 3 based on the drawing's features: 0: Not drawn. 1: Drawn, but no interaction with other subdimensions. 2: Drawn with interaction with one other subdimension. 3: Drawn with interaction with two or more other subdimensions. Table 1 shows the rubric for DAET-R.

The total DAET-R score, ranging from 0 to 12, indicates the drawing's ability to reflect environmental understanding. Scores are categorized as: Low: 0-4; Middle: 5-8; High: 9-12. A higher score signifies a more comprehensive environmental perception. In addition, the students provided short descriptions of their drawings to aid in the qualitative assessment. Previous studies have demonstrated the reliability and validity of the DAET-R. Moseley et al. (2010) found high inter-rater reliability and established construct validity, validating its effectiveness as a measurement tool. Similarly, Çalış & Balci's adaptation (2021), tested with 400 Turkish students, verified the rubric's reliability and suitability for the Turkish context. Based on these findings, the researchers opted not to perform an additional pilot test.

2.4 Data Gathering Procedure

Data collection took place during the students' lunch breaks to reduce interruptions. Informed consent was secured from the school principal, educators, and parents before the process started. Students were informed about the research and made aware that their participation was optional. During data collection, each student received a blank sheet for their drawing and another for their description. To encourage students' perceptions about the environment, researchers posed verbal prompts such as: *"What comes into your mind when you think about our environment?"* and *"What do you think constitutes the environment?"*. Students were instructed to omit their names but to specify their gender on the back of their drawings. Researchers cataloged and coded the drawing elements based on the students' descriptions. They were asked to refrain from interacting with one another during the activity to preserve the authenticity of their individual insights.

2.5 Data Analysis Procedure

Both quantitative and qualitative analyses were used in this study. Quantitative analysis utilized the elements from the students' drawings, scored on the DAET-R scale. Frequencies and percentages were calculated to assess the environmental components most frequently represented. The DAET-R scores were computed and analyzed using the Mann-Whitney U test to evaluate statistical differences by grade level. To understand the ecological components depicted in the drawings, the students' written and verbal explanations were qualitatively analyzed. Drawings and interview transcripts were analyzed to identify common themes, patterns, and key elements in the students' mental models. The explanations provided helped identify patterns and ensured that the rubric was scored carefully, so that the items were clearly understood from the students' point of view.

Table 1. *Rubric for DAET-R scores (Çalış & Balci, 2021)*

Factors	Scores			
	0	1	2	3
Human Factor	There is no human figure in the drawing.	The human figure is drawn without obvious interaction with other factors.	The human figure is depicted interacting with another person or factor(s), but specific interaction with the environment is not shown.	The human figure is clearly drawn in a system of interacting with one or more factors.
Biotic Factor	The drawing does not contain a biotic factor.	A biotic factor drawn has no interaction with the environment.	A biotic factor is drawn interacting with other factors, but the specific interaction with the environment is not clearly depicted.	A biotic factor is clearly drawn within a system in interaction with one or more factors.
Abiotic Factor	The drawing does not contain an abiotic factor.	An abiotic factor drawn has no interaction with the environment.	An abiotic factor is drawn interacting with other factors, but the specific interaction with the environment is not clearly depicted.	An abiotic factor is clearly drawn within a system in interaction with one or more factors.
Artificial Environment	The drawing does not contain any man-made elements.	Man-made elements like constructions are drawn without interacting with the surroundings. Constructions	Constructions are drawn as interacting with other factors, but specific interaction with the environment is not clearly depicted.	Constructions are clearly drawn within a system in interaction with one or more factors.

2.6 Ethical Considerations
Ethical approval was obtained through coordination with the School Administration. Participants were assured of their anonymity and the confidentiality of their responses. No personal identifiers were collected, and students were informed that their participation was voluntary and could be terminated at any time. The data were stored securely and accessed only by researchers. The study complied with ethical standards, namely informed consent, respect for privacy, and the Philippine Data Privacy Act of 2012.

3.0 Results and Discussion
3.1 Quantitative Data on Students' Environmental Perception
The perception of the environment by the grade school students of Pulangbato National High School, based on a mental model using DAET-R, is composed of (4) subdimensions/factors: biotic, abiotic, artificial environment, and human. Table 2 shows the frequencies and percentages for each subdimension, categorized by code. Of the 60 unique codes generated, the synthetic environment was most frequently depicted, accounting for half (30). This was followed by abiotic (13), biotic (9), and human (1) subdimensions.

Table 2. *Frequencies and percentages of the four subdimensions/factors of the environment derived from the drawings, as categorized by codes*

Code	Grade 7		Grade 10		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Biotic Factor						
Grass	7	23.33	2	6.67	9	15.00
Bird	2	6.67	4	13.33	6	10.00
Tree	13	43.33	12	40.00	25	41.67
Flower	6	20.00	1	3.33	7	11.67
Log	1	3.33	2	6.67	3	5.00
Plant	3	10.00	2	6.67	5	8.33
Dog	0	0.00	3	10.00	3	5.00
Cutted trees	2	6.67	4	13.33	6	10.00
Dead tree	0	0.00	1	3.33	1	1.67
Abiotic Factor						
Sun	8	26.67	5	16.67	13	21.67
Mountain	5	16.67	6	20.00	11	18.33
Sea	6	20.00	3	10.00	9	15.00
Air pollution	6	20.00	4	13.33	10	16.67
Cloud	6	20.00	5	16.67	11	18.33
Rock	1	3.33	0	0.00	1	1.67
Sand	1	3.33	0	0.00	1	1.67
Soil	0	0.00	1	3.33	1	1.67
Mars	0	0.00	1	3.33	1	1.67
New planet	0	0.00	2	6.67	2	3.33
Polluted sea	1	3.33	1	3.33	2	3.33
Forest fire	1	3.33	1	3.33	2	3.33
Cracked soil	0	0.00	1	3.33	1	1.67
Artificial Environment Factor						
House	11	36.67	5	16.67	16	26.67
Road	13	43.33	13	43.33	26	43.33
Hospital	3	10.00	0	0.00	3	5.00
Building	17	56.67	20	66.67	37	61.67
Church	2	6.67	0	0.00	2	3.33
Robot	2	6.67	8	26.67	10	16.67
Factory	3	10.00	7	23.3	10	16.67
Garbage	2	6.67	4	13.3	6	10.00
Car	5	16.67	11	36.67	16	26.67
Light post	2	6.67	1	3.33	3	5.00
Money	0	0.00	3	10.00	3	5.00
Electric post	0	0.00	1	3.30	1	1.67
Airplane	4	13.33	4	13.33	8	13.33
Boat	1	3.33	0	0.00	1	1.67
School	6	20.00	0	0.00	6	10.00
Spaceship	0	0.00	2	6.67	2	3.33
Vr	0	0.00	1	3.33	1	1.67
Train	0	0.00	5	16.67	5	8.33
Artificial beach	0	0.00	1	3.33	1	1.67
Cellphone	0	0.00	2	6.67	2	3.33
New technology	3	10.00	4	13.33	7	11.67
Mall	2	6.67	3	10.00	5	8.33
Flying broom	0	0.00	1	3.33	1	1.67

Bridge	0	0.00	2	6.67	2	3.33
Floating island	0	0.00	1	3.33	1	1.67
Gadgets	0	0.00	3	10.00	3	5.00
Submarine	0	0.00	1	3.33	1	1.67
New inventions	2	6.67	3	10.00	5	8.33
Traffic light	2	6.67	4	13.33	6	10.00
Bench	1	3.33	1	3.33	2	3.33
Car-boat	0	0.00	1	3.33	1	1.67
Satellite tower	0	0.00	2	6.67	2	3.33
Rockets	0	0.00	1	3.33	1	1.67
Hotel	2	6.67	1	3.33	3	5.00
Tractor	0	0.00	2	6.67	2	3.33
Motorcycle	0	0.00	1	3.33	1	1.67
Subway	0	0.00	1	3.33	1	1.67
Human Factor						
Human	4	13.33	12	40.00	16	26.7

Both Grade 7 and 10 students commonly included elements like roads, buildings, and cars in their drawings, with "buildings" being the most frequently drawn concept (56.67% for Grade 7, 66.67% for Grade 10). As students progressed to Grade 10, their drawings showed a clear shift toward futurism and technological advancement, with inclusions such as robots (26.67%), factories (23.33%), new technology (13.33%), and new inventions (10.00%).

In the abiotic subdimension, both Grade 7 and 10 students most frequently drew the sun (26.67% and 16.67% respectively), followed by mountains (16.67% for Grade 7, 20.00% for Grade 10), reflecting a focus on the natural environment. Students also depicted environmental concerns, with air pollution appearing in 20.00% of Grade 7 and 13.33% of Grade 10 drawings, and polluted seas in 3.33% of both. Grade 10 students also showed awareness of ecological damage through concepts such as cracked soil and forest fires, though less frequently.

In the biotic subdimension, trees were the most common element, appearing in 43.33% of Grade 7 and 40.00% of Grade 10 drawings. Grass was also prominent, especially in Grade 7 (23.33%) compared to Grade 10 (6.67%). Other biotic elements, such as birds (6.67% in Grade 7, 13.33% in Grade 10) and flowers (20.00% in Grade 7, 3.33% in Grade 10), were less frequent. Interestingly, dogs appeared in 10.00% of Grade 10 drawings, suggesting that awareness of human-animal relationships increases with age. These evolving perceptions likely stem from students' direct experiences in nature; those who spend time outdoors tend to view the environment differently than those who don't. This highlights a crucial point for sustainability: Ahi & Kahriman-Pamuk (2021) emphasize that strengthening students' ties to the environment is key to fostering sustainability.

Human figures were depicted more frequently by Grade 10 students (40.00%) than by Grade 7 students (13.33%). This trend suggests that as students mature, their environmental perceptions increasingly incorporate the human presence and its potential impact on the environment.

Distribution of Students' DAET-R

Table 3 outlines the distribution of students' scores on the DAET-R subdimensions for Grade 7 and Grade 10 students. Grade 7 students largely excluded human figures from their drawings, with 83.33% scoring 0 in the human sub-dimension. Only a small percentage of Grade 7 students depicted human figures with some interaction: 6.67% showed no interaction with other elements (score 1), another 6.67% showed interaction with one other sub-dimension (score 2), and only 3.33% showed interaction with two or more sub-dimensions (score 3). Among Grade 10 students, 60.00% also scored 0, indicating they did not draw human figures. While 6.67% scored 1, a larger proportion (26.67%) scored 2, indicating human figures interacting with one another within the sub-dimension. Only 6.67% (two students) achieved a score of 3, indicating that they depicted human figures interacting with two or more sub-dimensions.

Table 3. *Distribution of students' DAET-R sub-dimension scores obtained from drawings*

Code	**Human**				**Biotic**				**Abiotic**				**Artificial Environment**			
	Grade 7		**Grade 10**		**Grade 7**		**Grade 10**		**Grade 7**		**Grade 10**		**Grade 7**		**Grade 10**	
Score	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	25	83.33	18	60.00	8	26.67	10	33.33	12	40.00	11	36.67	1	3.33	2	6.67
1	2	6.67	2	6.67	19	63.33	16	53.33	15	50.00	14	46.67	21	70.00	9	30.00
2	2	6.67	8	26.67	3	10.00	4	13.33	3	10.00	5	16.67	8	26.67	19	63.33
3	1	3.33	2	6.67	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**

In the biotic sub-dimension, 26.67% of Grade 7 students scored zero, indicating they didn't draw any biotic elements. Most (63.33%) scored 1, indicating they drew biotic elements without interaction, while 10.00% scored 2, indicating interaction with one other sub-dimension. For Grade 10 students, a higher percentage (33.33%) scored zero, suggesting more difficulty in representing biotic elements. Half (53.33%) scored 1, drawing biotic elements without interaction, and 13.33% scored 2, indicating interaction with one other sub-dimension. Notably, no students in either grade scored 3, revealing a general struggle to depict biotic elements interacting with two or more other sub-dimensions.

In the abiotic sub-dimension, 40.00% of Grade 7 students scored 0, indicating they didn't draw abiotic elements, while 50.00% scored 1, indicating they drew abiotic elements without interaction. Only 10.00% (three students) of Grade 7 students scored 2, showing interaction with one other sub-dimension. For Grade 10, 36.67% scored 0, a slight decrease from Grade 7. Nearly half (46.67%) scored 1, drawing abiotic elements without interaction, and a slightly improved 16.7% scored 2, indicating interaction with one other sub-dimension. Crucially, no students in either grade scored 3, highlighting a general difficulty in integrating abiotic elements into a broader environmental context within their drawings.

In the artificial environment sub-dimension, only 3.3% of Grade 7 students scored 0 (did not draw artificial elements). The majority (70.00%) scored 1, depicting artificial environments without interaction, while 26.67% scored 2, showing interaction with one other sub-dimension. For Grade 10, 6.67% scored 0. A smaller proportion (30.00%) scored 1, while a significant 63.33% scored 2, indicating that over half of Grade 10 students integrated artificial elements with another sub-dimension in their drawings. No students in either grade scored 3, suggesting a continued difficulty in fully integrating artificial environments with two or more other sub-dimensions.

According to Çalış & Balci (2021), the human figure has an essential place in the representation of the environment. Despite this, the present study found that most Grade 7 and 10 students' DAET scores for the human sub-dimension were zero, suggesting they don't perceive humans as an integral part of the environment. Furthermore, no students achieved a score of 3 across any sub-dimension, indicating a general struggle to show full integration and interconnectedness between human, biotic, abiotic, and artificial environmental elements. This highlights a significant gap in their ecological literacy and systems thinking.

Distribution of Total Scores Obtained from Draw an Environment Test - Rubric

Table 4 shows the distribution of total scores obtained from the Draw an Environment Test Rubric (DAET-R). The total scores indicated that most students across both grade levels struggled to comprehensively depict environmental concepts. Grade 7 students showed difficulty, with 76.67% scoring low (0-4). This indicates that most either didn't attempt to draw environmental elements or failed to represent them effectively. Only 23.33% achieved a middle score (5-8), indicating moderate proficiency, and none scored high (9-12), indicating none demonstrated the highest level of environmental thinking or integration. Grade 10 students performed slightly better but still faced challenges. 66.67% scored low (0-4), indicating persistent difficulty with the task. However, one-third (33.33%) scored in the middle range (5-8), suggesting a slight improvement in representing and integrating environmental elements compared to Grade 7. Consistent with Grade 7, no Grade 10 students scored high (9-12), reflecting a continued struggle to demonstrate advanced integration and complexity in their environmental drawings.

Table 4. *Distribution of total scores obtained from Draw an Environment Test – Rubric*

Total Score	Grade 7		Grade 10		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0-4	23	76.67	20	66.67	43	71.67
5-8	7	23.33	10	33.33	17	28.33
9-12	0	0.00	0	0.00	0	0.00
Total	**30**	**100.0**	**30**	**100**	**60**	**100.0**

A study by Mantilla & Acledan (2022) found that a mean DAET-R score of 5 indicates students lack a crucial understanding of the interplay between living and nonliving elements, perceiving the environment only as separate biotic and abiotic factors. The absence of students scoring in the 9-12 range across both grades further suggests the struggle to achieve a high level of environmental systems thinking. Bayati (2023) showed that inadequate knowledge often results in negative attitudes or misjudged ecological impacts. Van de Wetening et al.

(2022) demonstrate the potential for environmental education to improve students' environmental knowledge, attitudes, intentions, and behavior. Thus, to cultivate pro-environmental attitudes in the Philippines, our ecological education must emphasize human-environment relationships.

The Difference in the Total Drawing Scores Between the Grade Levels

Table 5 reveals a significant difference in environmental perception between Grade 7 and Grade 10 students, suggesting that environmental mental models become more sophisticated with higher grade levels. This improvement is likely due to increased education. This finding aligns with Ahi et al. (2017), who found that later-year students had more developed environmental mental models, as evidenced by their drawings, which included more elements and demonstrated a better understanding of ecological interconnectedness.

Table 5. *Difference in the total drawing scores between the grade levels using a Mann-Whitney U test*

Grade Level	n	Mean Rank	Sum of Rank	U-value	*p-value*
Grade 7	30	25.24	732	297	0.019
Grade 10	30	34.6	1038		

Grade 7 students largely perceive the environment as simply the natural world outside their immediate surroundings (trees, animals, air), indicating a narrow understanding. In contrast, Grade 10 students demonstrated a more sophisticated experience, encompassing physical, social, and cultural dimensions alongside natural elements. Their perceptions extended to include the air, buildings, and communities. Grade 10 students also viewed the environment as a dynamic system, recognizing its evolution with human behavior, technology, and ecological processes. This was evident in their shift towards depicting futuristic environments influenced by human innovation and environmental challenges, aligning with research showing students consider technology in broader societal and environmental contexts. This finding aligns with Yalcin & Alkar (2024), who observed that students consider technology's broader social, environmental, and scientific implications, beyond just personal use. Students' access to technology and online networks offers new insights about the environment (Kraalingens & Beames, 2023).

3.2 Qualitative Data on Students' Environmental Perception

The students' responses to the question *"What comes into your mind when you think about our environment?"* and *"What do you think constitutes the environment?"* revealed diverse perspectives. Both Grade 7 and Grade 10 students identified a mixture of natural components, human influence, and built structures. The following themes emerged from their responses:

First, natural elements such as trees, plants, and greenery were consistently mentioned across both grade levels, indicating a clear association between the environment and the natural world. Both grade levels referred to trees as helping prevent floods and landslides and creating beautiful surroundings. When students were asked what makes the environment, they mentioned "*environment has trees*", others mentioned "*huge trees*" to be exact, and another one noted, "*environment has trees, nature, and soil*". A part of the natural environment — clean water, lakes, and rivers —was also commonly mentioned at both grade levels, underscoring the importance of water in our environment.

Second, animals were also mentioned most often at both grade levels, with students describing a peaceful coexistence of animals in our environment. A grade 7 student mentioned, "The environment has a cute animal," another one mentioned, "*Environment has a variety of animals," and a grade 10 student mentioned, "living things make the environment...".*

Third, soil, nature, and agriculture also emerged as essential elements, as in responses such as *"nature, soil, trees, and flowers"* by a grade 7 student and *"natural resources like plants, trees, and land"* by a grade 10 student.

Fourth, human structures such as houses, buildings, roads, and cities were also frequently cited, indicating an understanding that the built environment is an integral part of what constitutes *"the environment."* A grade 7 student mentioned *"houses, trees, buildings, and people,"* and *"people and houses"* by a grade 10 student. The students' responses reflect an evolving understanding of how they view the environment. Grade 7 students mostly see the environment as visible, tangible elements such as trees, animals, water, and human-made structures like houses and roads. Grade 10 students, on the other hand, viewed the environment as interconnected between human activity and the natural environment.

The findings of this study suggested the following learning activities to improve students' environmental perceptions, awareness, and literacy. First, increase students' environmental education through hands-on activities. Field trips to natural ecosystems or to human-made spaces such as zoos and nature centers allow students to observe ecosystems, identify plants and animals, and study natural processes (Sunasee et al., 2021; Larasaty et al., 2024). In the classroom, projects like making compost bins, monitoring water use, designing energy-saving devices, or growing vegetables, herbs, or flowers can teach about conservation and sustainability (Larasaty et al., 2024). Creating natural habitats, such as terrariums, allows students to build and study a self-contained ecosystem that simulates a "*mini biosphere.*" This helps them analyze how non-living elements, such as soil, water, and light, support life, as on our planet. Additionally, building birdhouses, insect hotels, or pollinator gardens can help local biodiversity (Ramos et al., 2024).

Second, Eco-art education. This evolving approach merges art and environmental education, using local environments as learning spaces to cultivate a lasting appreciation for nature and foster sustainable behaviors. Students are encouraged to connect with nature by documenting their observations, thoughts, and feelings through writing, drawing, photography, or in a nature journal or scrapbook (Sunasee et al., 2021).

Third is game-based learning and engagement. Game-based learning is a highly effective educational approach. It provides a safe environment for students to collaborate, negotiate, and solve problems, which can ultimately lead to a change in their behavior and the development of new ideas. By simulating real-world contexts, games facilitate experiential learning and enhance student engagement (Vazquez-Vilchez et al., 2021).

Numerous games present several opportunities to explore multiple facets of environmental perceptions, awareness, and literacy. For example, Games like "A Planet Near the Abyss", "Eco," and "Dirty Matters" allow students to explore and learn about different ecosystems, conservation strategies, and the importance of soil health (Fjællingsdal & Klöckner, 2019; Vazquez-Vilchez et al., 2021; Moore, 2025). Students can also practice conservation and sustainability in "Stake for the Forest," tackle carbon policy in "Carbon City Zero," and learn about balancing human needs with environmental protection in "Go for the Green" (Moore, 2025). Games such as "Los Cokitos," "Pocoyo," and "TrashFun" teach practical skills by challenging students to sort and recycle different types of waste; encouraging good habits and environmental awareness (Fjællingsdal & Klöckner, 2019; Ricoy & Sanchez-Martinez, 2022).

Fourth, adopt technology for environmental education. Digital tools offer students a safe and accessible way to explore complex environmental topics. For instance, an environmental virtual field laboratory that can mimic real-world excursions, such as a trip to Florida's flatwood landscapes to study soil and drainage. Moreover, virtual field trips, like those in Mexico's Chinampa region, teach about soil degradation and the collapse of civilizations. In Taiwan, a virtual marine museum educates students about marine ecology (Hajji-Hassan et al., 2024). In the Philippines, virtual museums such as the UPLB Museum of Natural History, Museo Kalikasan, and the Nemenzo Virtual Museum offer interactive online experiences that showcase the country's rich biodiversity.

Augmented reality (AR) is also a powerful tool for environmental education. It overlays digital content, such as images and animations, onto the real world, creating an interactive learning experience. This technology helps students visualize complex environmental ideas and models, promoting critical thinking and engagement. As a result, AR can significantly improve learning outcomes by making lessons accessible and interactive anytime, anywhere (Safiti et al., 2025).

Another modern teaching method that uses technology is digital storytelling. It is a digital narrative to make learning more engaging. It helps students connect real-world issues, such as environmental awareness, to their academic studies. This approach is especially effective at boosting critical thinking and language skills (Perdana et al., 2025). Holistically, for these learning activities to be successfully implemented nationwide, teachers must receive adequate training.

4.0 Conclusion

This research study explored the environmental perceptions of Grade 7 and Grade 10 students at Pulangbato National High School. By analyzing their drawings, we found that students' environmental perceptions develop with education, integrating human, biotic, abiotic, and artificial factors. However, significant gaps in ecological literacy and systems thinking persist.

While Grade 7 students primarily depicted natural elements, Grade 10 students incorporated more complex themes, such as technological advancement and environmental challenges. However, neither group demonstrated the highest level of conceptual integration.

To cultivate sustainable environmental stewardship, educational curricula must prioritize experiential and systems-based learning, fostering critical thinking and ecological responsibility. Students need engagement with real-world issues through interdisciplinary approaches to bridge the knowledge-action gap. Hands-on, experiential learning, integrated with art, games, and technology, is crucial for improving students' environmental perception, awareness, and literacy. Crucially, teacher training in experiential learning, technology integration, and hands-on protocols is essential to equip educators to facilitate this deeper learning.

It should be noted that the findings of this study are limited by a small sample size, a specific geographic location, and potential response bias, which may affect their generalizability. Therefore, future studies should include a larger, more diverse sample. This could involve recruiting students from different regions, schools (e.g., public vs. private), and socioeconomic backgrounds. Expanding the study to multiple geographic locations would help ensure the results are not limited to a single, localized environment. Observing participants and their behaviors can provide a more objective measure of environmental perceptions, awareness, and literacy than self-reported data, which can be subject to bias.

5.0 Contribution of Authors

Anna Nessa Gio: conceptualization, proposal writing, data gathering, data analysis, manuscript writing, and revision
Anna Jane Gio: conceptualization, proposal writing, data gathering, data analysis, manuscript writing, and revision
Karylle Gadina: conceptualization, proposal writing, data gathering, manuscript writing
Angelyn Saguban-Bornea: conceptualization, proposal writing, data gathering, manuscript writing
Joshua Balinas: conceptualization, proposal writing, data gathering, manuscript writing
Venus Kinamot: conceptualization, proposal writing, data analysis, manuscript writing, and revision

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7.0 Conflict of Interest

This study declares no conflict of interest.

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