

Evaluating Environmental Awareness in Practice on the Concept of Nutrient Cycling Among Senior High School Students

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Abstract. Nutrient cycle, a concept that highlights the path that nutrients follow as they travel from the soil to the plant and other organisms, is an important concept for students to understand since it connects human actions to their effects on the environment. Understanding how the nutrient cycle works, especially in the context of lake water, is crucial in managing ecosystems effectively and mitigating the impacts of pollution, especially when it is because of anthropogenic causes. Therefore, there is a need to integrate environmental education into class lessons so that society can fully grasp the relationship between science and society. This study surveyed a total of 110 students from three different schools using simple random sampling. These schools near Laguna Lake of Los Baños, Laguna were randomly selected. Schools near the lake were targeted because they were relatively familiar with the topic. The survey assessed environmental awareness in three categories: knowledge, attitude, and practice, validated through Cronbach's Alpha test. From the data collected the respondents were found to have low awareness in terms of knowledge (44.6%), high awareness in terms of attitude (83.6%), and a moderately low awareness in terms of practice (67.6%). This suggests a need to enhance student understanding of environmental concepts and issues to improve their practices. Thus, motivating them in adopting sustainable practices. Overall, the results from this study support the premise that there is a need to create teaching materials and activities to improve the practices of the students.

1 Introduction

The Philippines like other countries is facing environmental challenges. And because of this, there is a need to protect and conserve the environment. One perpetuating problem in the Philippines is deforestation which has a severe impact on the aquatic environment [1, 2, 3]. Deforestation causes huge losses of biological diversity and serious consequences for human health, such as outbreaks of new diseases [4]. Nutrient cycling is severely impaired by deforestation and can result in serious farm productivity to water pollution problems. Nutrient cycling is a concept that highlights the path that the nutrients take as they get transported

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from the soil to the plant and other organisms [5, 6]. The concept is vital information for students as it relates human activities to the effects on the environment. A very practical example is the overloading of nutrients in the water systems, triggering eutrophication leading to fish kill, and proliferation of harmful red tide organisms, which can eventually lead to human poisoning. Eutrophication refers to the increase in the rate of delivery of organic materials into an ecosystem [7].

According to [8] and [9] this aspect leads to habitat modification and the geographical and temporal spread of some hazardous algal bloom (HAB) species. Therefore, there is a need to integrate environmental education. This would enhance understanding of the relationship of the science of nutrient cycling to our environment, specifically the aquatic environment, and in return, they can make environmentally sound decisions in their everyday life.

In a recent study about environmental literacy among Grade 10 completers, it was found that although students may have pro-environment knowledge, this does not necessarily translate into pro-environment practices [10]. In the study of [11], chemistry education students had lower levels of environmental awareness than non-chemical education students, except in the knowledge variable. This was attributed to the time needed for the values to be developed among students. Therefore, it is common to see students having high environmental awareness in terms of knowledge, but lag in terms of practice [12]. Thus, the integration of environmental issues and awareness in the curriculum to improve the attitude of the students towards environmentally sustainable practices was highly recommended [13, 14, 15, 16]. Westrum stressed the inclusion of real-life local problems can stir students' interest, participation, and commitment [17].

This current study aims to investigate the level of environmental awareness of students on the concept of nutrient cycling as applied to the aquatic ecosystem among Grade 11 students of Los Baños Senior High School (LBSHS). Specifically, this study aims to do the following: 1) determine the knowledge that the students have towards taking care of the aquatic ecosystem, 2) evaluate the attitude that the students have toward taking care of the aquatic ecosystem, and 3) analyze the practices of the students towards taking care of the aquatic ecosystem. SE 170 x 250 mm paper size (W x H mm) and adjust the margins to those shown in Table 1. The final printed area will be 130 x 210 mm. Do not add any page numbers.

2 Materials and Methods

Figure 1 shows the general methodology used in this study. This is a quantitative type of research utilizing a survey questionnaire modified from [11].

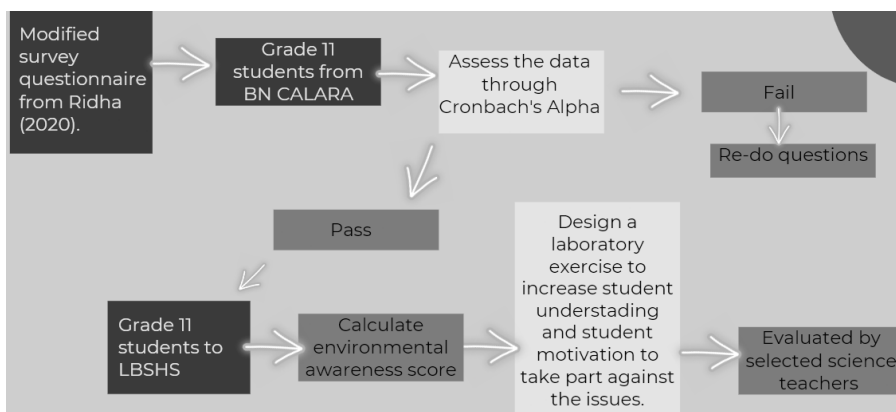


Fig. 1. General Flow of the Methodology.

The questionnaire uses the Likert scale and starts from 1 (never heard) to 5 (already a master), specifically for the knowledge category. Table 1 shows the description of the Likert scale in all the general items of the questionnaire (knowledge, attitude, practice). This scale is expected to explain a student’s level of environmental awareness. The knowledge-based questions cover various topics, including eutrophication, microplastics, and the effects of human activity on the aquatic environment (Table 2). On the other hand, the attitude-based questions delve into topics like waste management, aquatic pollution reduction, water conservation, and others (Table 3). Finally, the practice-based questions consist of waste management practices and others (Table 4).

Table 1. Description of 5 point likert scale for environmental awareness.

Scale Type	Knowledge	Attitude	Practice
1	Never heard	Not yet aware	Never
2	Already know but cannot explain it in detail	Already aware but do not have the desire to do it	Rarely
3	Understand and be able to discuss	Realize but am not sure I can do it	Sometimes
4	Understand and am able to discuss and connect with various other issues	Already aware and plan to do it	Always
5	Already an expert	Already aware and ready to do it	Often

Table 2. Description of 5 point likert scale for environmental awareness.

Question on Knowledge	
Do you know what water pollution is?	Do you know what water pollution is?
Do you know what eutrophication is?	Do you know what eutrophication is?
Do you know what causes the red tide phenomenon	Do you know what causes the red tide phenomenon
Do you know about the Clean Water Act of 2004?	Do you know about the Clean Water Act of 2004?
Do you know about the Environmental Educational Act?	Do you know about the Environmental Educational Act?
Do you know how oil spills affect the aquatic environment?	Do you know how oil spills affect the aquatic environment?

Table 3. Survey questionnaire on environmental awareness on attitude on water pollution.

Question on Attitude	
Throwing garbage just anywhere is bad	I know that microplastics have a big effect on the aquatic environment and humans, so I dispose of them properly.
I am responsible for my own garbage	I know that I have to segregate waste starting from my house.
I know composting organic materials (plant and animal remains) rather than burning them is better for the aquatic environment	I know that “The ocean starts at my sink”
I know that deforestation is bad for the aquatic environment in the long run that is why I plant trees/support tree planting	

Table 4. Survey questionnaire on environmental awareness on practice on water pollution.

Question on Practice	
I throw my garbage in a trash can or keep it in my bag	I do not use sunblock when I swim in rivers, lakes, or the ocean.
I use the three R's (reduce, reuse, recycle)	I watch what I throw in my sink
I pee in the designated place	I push my family/ I compost my organic waste rather than throw it in a trash can
I try to join tree-planting activities when there is an opportunity	I segregate my trash
When it floods and I see that the drain is blocked, I remove the debris	

The questionnaire was subjected to a test run using 47 Grade 11 students randomly sampled from BN Calara Senior High School, and the results were subjected to a Cronbach's Alpha test to calculate the reliability of the questions in the questionnaire (Table 5). After determining and confirming the reliability of the questionnaire by the Cronbach's Alpha test, the questionnaire was then given to 63 random Grade 11 students from Los Baños Senior High School.

Table 5. Cronbach's alpha result.

Reliability Statistics (Overall Reliability)					
Knowledge		Attitude		Practice	
Cronbach's Alpha	Number of Items	Cronbach's Alpha	Number of Items	Cronbach's Alpha	Number of Items
0.865	10	0.878	7	0.832	8

The respondents of the study targeted Grade 11 students from Los Banos Senior High School (LBSHS). The respondents were chosen using a random sampling technique. The study focused on Grade 11 students because environmental literacy is a basic learning competency at the end of Grade 10 [18]. Students should have gained scientific, technical, and environmental literacy, and should be able to make reasoned decisions about challenges that confront them. Because LBSHS is a melting pot of diverse student types from various localities and social classes, it was considered a prime location to gather respondents. The percentage of environmental awareness for each category was determined using the formula:

$$Score = \frac{Total\ score\ for\ each\ subject}{Ideal\ score} \times 100 \tag{1}$$

3 Results and Discussion

3.1 Environmental awareness in terms of knowledge

The respondents fell short regarding environmental awareness, particularly on the perpetuating water pollution brought about by eutrophication. They found it challenging, as seen in Table 3 and Figure 2. There are 45 respondents out of 60, who answered that they have never heard of the concept of eutrophication before, indicative of low knowledge in terms of this concept. However, according to the Dep-Ed curriculum, the concepts of water pollution and eutrophication are supposed to be discussed during the fourth quarter in the 8th and 10th grades [18].

Table 6. Environmental awareness results.

Environmental Awareness Category	Score (%)*
Knowledge	44.6
Attitude	83.6
Practice	67.6

*Obtained using equation 1

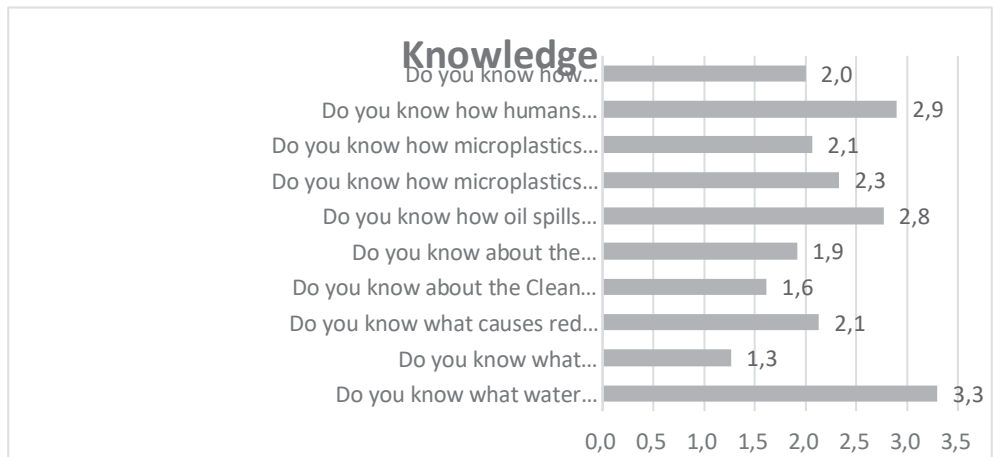


Fig. 2. Level of knowledge per indicator.

Overall, the level of environmental awareness of the respondents in the knowledge category is around 44.6% as seen in Table 3. This level is not that high and did not even reach 50%. This implies that more serious steps should be taken to improve the students' environmental awareness in the category of knowledge. This will have very serious consequences, some of which we are already experiencing.

Having a good stock of knowledge ideally simplifies the process of acquiring new learning [19]. When a student has inaccurate prior knowledge on the topic it may lead to misunderstandings resulting in misconceptions [20, 21, 22]. For example, in the study of Clement [23], it was found that at the start of the topic introduction to mechanics course 88% of engineering and science students had pre-course misconceptions about the motion of objects. The students may give up their misconceptions temporarily. However, they then revert to their earlier misconceptions after completing a course. A lack of knowledge also hinders the transfer of learning. Consequently, when students lack a solid understanding, they face challenges in comprehending how to apply their knowledge and skills to unfamiliar situations [24, 25]. Finding the best and doable solution is urgent.

3.2 Environmental Awareness in terms of Attitude

Unlike the possession of knowledge on environmental awareness, the attitude of the respondents towards the environment is relatively high, 83.6% (Table 3). The results showed that the students agreed about being responsible for their environment. This means that overall, most of the students had a positive attitude about environmental awareness. This suggests that the students recognize the significance of responsible waste management, composting, trash segregation, tree planting, and avoiding improper microplastic disposal (Figure 3). This indicates that the students have a positive attitude and are willing to engage in environmentally beneficial actions. This finding is very encouraging. This can be the start of a very meaningful and hopefully impact protection of our environment.

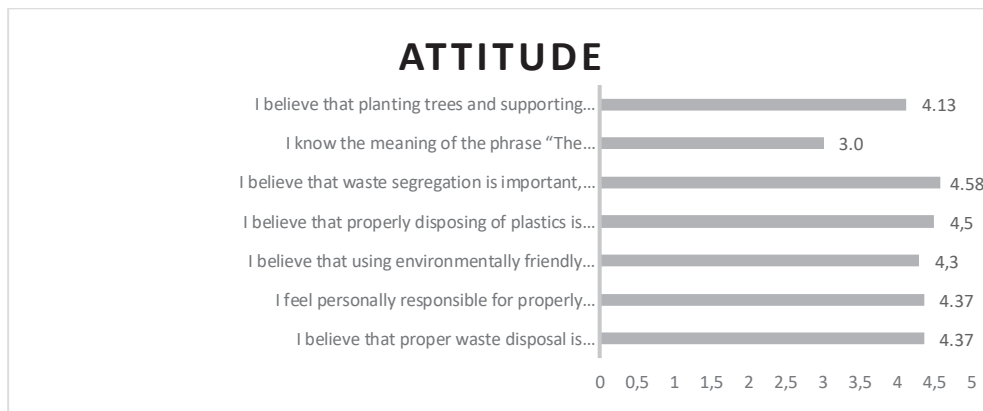


Fig.3. Level of attitude per indicator.

3.3 Environmental Awareness in Terms of Practice

The respondents have a relatively moderate score (67.6%) in environmental awareness regarding practice (Table 3). This implies that they are willing to care for the environment by disposing of their garbage properly, using the three R's (reduce, reuse, recycle), peeing in designated places to prevent water pollution, avoiding the use of sunblock when engaging in activities done in natural water bodies, being mindful of the materials that go down their sinks, composting organic waste, participating in tree planting activities, removing debris from blocked drains, and segregating their trash (Figure 4). Results indicate students' willingness to take action against the ongoing lake water pollution. However, those who might not have enough knowledge may struggle to motivate themselves to sustain these favorable practices. In the study of [26], they found a positive correlation between the knowledge and practice of an individual. In another study, the respondents who demonstrated a high level of knowledge also exhibited a high level of practice [27]. Additionally, in the study of [28], they found that the lack of students' awareness of Hepatitis B on the topics of transmission and prevention and the absence of their vaccinations against it has a strong independent correlation, meaning the low knowledge of the students on the topic affected the practices that they do. Implications of this relationship between knowledge, attitude, and practice can be quite risky and dangerous, especially in the context of human diseases. In a study [29], it was revealed that secondary school students have poor knowledge of breast cancer and breast self-examination (BSE), hence, only a few of the students practiced breast self-examination which could be disastrous. Since women are more prone to breast cancer, knowing how to detect early breast cancer signs with the use of BSE can improve women's well-being. The same could be true of the current condition of our aquatic environmental pollution. This could become disastrous affecting health, livelihood, and overall community wellness [30].

In Figure 2, the students were asked if they knew the effect of deforestation on water pollution. Incidentally, the students answered that they are only familiar with deforestation but cannot explain how it relates to water pollution. This implies a lack of thorough understanding of the concept and its domino effect in other ecosystem landscapes, even the farthest aquatic and marine ecosystems. This lack of knowledge can result in non-commitment in joining relevant activities such as tree planting which will indeed address the current problem in our aquatic bodies. Findings suggest the need to restructure activities for this topic among Grade 10 students. A simple laboratory activity exposes them to the drivers of aquatic ecosystem pollution. Consequently, this will enhance student knowledge and motivation in order to sustain regular good practice.



Fig. 4. Level of practice per indicator.

As seen from the data, the respondents have low environmental awareness in the knowledge category, high environmental awareness in the attitude category, and relatively moderate environmental awareness in the practice category. This implies that the students have a positive disposition towards environmental awareness and their positive attitude will help motivate them in adopting sustainable practices to take good care of the environment. However, the low knowledge from Table 3 suggests that there is a need to enhance student understanding of environmental concepts and issues. By improving their knowledge, they will be better equipped to make informed decisions and develop strategies for environmental conservation. The moderate score on practice suggests that students are engaging in some friendly practices. However, there is still an opportunity to further strengthen and promote consistent adoption of these practices. The lack of understanding or awareness of certain environmental concepts and issues contributes to the student’s inability to fully engage in sustainable practices. Without sufficient knowledge, the students cannot grasp the importance or consequences of their actions. This leads to inconsistent or limited adoption of environmentally friendly behaviors.

It is important to address the knowledge gap, enhance their practices, and hence produce environmentally aware and proactive individuals [31, 32, 33, 34]. It is a known fact that a lack of knowledge of the consequences of human actions on the environment will prevent people from doing correct and sustainable practices.

The knowledge about environmental awareness basically necessitates the understanding of nutrient cycling dynamics. Eutrophication is one of the detrimental consequences of an insufficient understanding of nutrient cycling dynamics [35]. The following are ways eutrophication affects the environment a) agriculture and livestock, from the use of too much fertilizers and from the manure of the livestock flowing down to the rivers and lakes overloading it with nutrients; b) construction, for causing soil erosion and the soil full of nutrients such as nitrogen and phosphorus will flow down into the rivers and lakes causing an overload in nutrient; c) households, for using too much fertilizer in their garden and the soil full of fertilizer with nutrients such as nitrogen and phosphorus will flow down into the rivers and lakes causing an overload in nutrient; d) inadequate waste water treatment plants, when the wastewater from households and factories are not processed correctly and they release high levels of nitrogen and phosphorus into rivers and lakes causing an overload of nutrients; and e) factories, when they don’t have a treatment plan for their waste and lets it out into the rivers causing an overload of nutrients [36, 5, 37, 38].

Nutrient cycling is the movement of nutrients, such as carbon, nitrogen, phosphorus, and other elements, through the biotic and abiotic components of an ecosystem [39]. It is the fundamental foundation in understanding how human activities can influence the movement of nutrients in the environment which may either be detrimental or beneficial, depending on

how humans behave and act [40]. It is important to understand that nutrient cycling itself does not cause pollution. However, if outside sources were to overload the cycle such as anthropogenic causes, then it would cause a leak in the cycle in the form of pollution.

Understanding how the nutrient cycle works is crucial in managing ecosystems effectively and mitigating the impacts of pollution [41, 42, 43]. Scientists and policymakers can develop ways to reduce nutrient pollution, promote sustainable nutrient management practices, and restore polluted ecosystems and ecosystem services by understanding the nutrient cycling processes. Thus, while nutrient cycling is an essential ecological process, it is only one piece of the broader puzzle when it comes to understanding and addressing pollution.

Integrating a laboratory activity can be worthwhile to address the gaps. This was shown by [44] found that laboratory exercises on spectral visual approaches increased student retention of the concepts. In addition, in the study of [45], they introduced an online laboratory exercise for their physics topic which was positively accepted by the students. Indeed, designing a laboratory exercise that incorporates social issues in science will increase student understanding of the concept and increase student motivation to act against the issue [46, 17, 47, 48].

4 Conclusions

The level of environmental awareness of students towards stewardship of aquatic ecosystems among Grade 11 students of Los Baños Senior High School (LBSHS) was determined through a survey questionnaire reliably confirmed by Cronbach's Alpha Test. Results showed that the respondents have low environmental awareness in the knowledge category, high environmental awareness in the attitude category, and relatively moderate environmental awareness in the practice category. In the knowledge category, the students found the topic of eutrophication to be unfamiliar. Although the students understand that they are responsible for the environment and show that they want to take care of the environment, due to their lack of understanding of the concepts such as eutrophication, they do not know how to better take care of the environment and thus do not know what practices best fit their situations. In addition, without a good grasp of the concept, the students would not be able to understand the consequences brought by their actions towards the environment, and thus cause harm to the surroundings. Therefore, by enhancing their knowledge of the concepts, they will be better informed and will be able to take care of the environment by being proactive individuals. This can be done using a simple laboratory activity. A simple high school laboratory focused on lake water pollution can be set up. It should show students the many drivers of lake water pollution: biophysical and socioeconomic factors play a very crucial role in lake water pollution. Identifying these drivers will help students identify the strategic solution.

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