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RESEARCH ARTICLE

Assessing Environmental Literacy and Exploring Citizen Science Capability Among Grade Six Learners in the Philippines

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Abstract

Objective: To assess grade six learners' environmental literacy and citizen science capability in schools along Tigum River, Iloilo, Philippines. **Methods**: The study employed a descriptive survey design adopted and revised researcher-made questions validated by science experts in the Province of Iloilo, Philippines. The survey questionnaires were focused on environmental literacy instruments in the Middle School Environmental Literacy Survey Instrument in the United States. Another questionnaire was citizen science capability, which the researcher made. The participants are twenty-nine (39) schools with a total of three-hundred-fifty (350) grade six learners found along Tigum River in the Province of Iloilo, Philippines, academic year (AY) 2017-2018. The researcher randomly selected the participants. The statistical tools used were frequency, mean, and standard deviation and SPSS version 21 was utilized to get the results. **Findings**: The profile of grade six in terms of various categories was interpreted as average regarding ecological knowledge but high in Special Science Classes. In verbal communication, responses in terms of saving water were interpreted as high and average if action was required. But in actual commitment, almost all categories were described as high but average on buying charcoal and low on turning faucets when not in use. Environmental sensitivity was labeled high but lacking in outdoor activities and collecting wild animals. And for the science capabilities, citizen science capability (biodiversity, water quality, and solid waste management) were decoded as capable. One important reason for this response is related to teachers' knowledge of environmental science teaching. This study emphasizes that learners can do citizen science projects that direct the school curriculum to consider the community as a context of learning for environmental education. **Novelty and Suggestions**: Through the Department of Education (DepEd), the national government supports teachers using local biodiversity as materials to improve science teaching and learning. The unique thing about this study is that it can help educate young minds as warriors to protect and preserve our ecosystem, specifically in freshwater. Science literacy depends on the

commitment of all stakeholders in the academy.

Keywords: Environmental literacy; Citizen science; Elementary grades learners; Survey

1 Introduction

Environmental literacy is about knowledge of the local environment and the world. This is also an understanding of how we use resources from our surroundings. Further, our understanding of the natural environment and human activities is vital. Learners should be provided with the necessary knowledge and skills about the world in which they live. Countries like the USA have already formulated a framework for integrating environmental education into the curriculum [(1)]. The Philippines is always encouraging teachers to make use of resources available locally. Teachers in science already create different man-made ecosystems inside the campus for instructional materials in teaching biodiversity.

One study was a preliminary survey of flora and fauna in Western Philippines, specifically in the Municipality of Sara, Iloilo – Sampunong Bolo Bird Sanctuary. The area is rich with various biodiversity and has the potential for science teaching and learning [(2)]. Thus, one local biodiversity in science pedagogy showed promising and can be integrated as instructional materials. The use of localization and contextualization can be a way to help protect and preserve natural resources [(3)].

One study about science literacy in the junior high school Science and Technology Program (STEP) revealed writing skills were better than paper presentation. The help of teachers and key officials, and the learning environment affects science literacy. Thus, the study recommends identifying essential factors to help the science and teaching process. However, the research on the relationship between environmental literacy, locus of control, and future orientation of STEM students in the Philippines was based on different factors. The students have very low knowledge about the environment [(4)].

In the Philippines, environmental literacy is one of the most diverse and exciting studies; however, most of the findings were fair or unsatisfactory. Many results were enigmatic and needed more verification. Thus, developing environmental literacy also prepares people to understand common issues and problems of the environment [(5)]. Also, one study finding showed that learners have a shallow and narrow understanding of environmental education. The findings also exposed that teachers have limited knowledge of the concepts and topics in environmental education, resulting in ineffective transfer of learning [(6)].

To develop environmentally literate citizens and to respond to these complex environmental issues, one study stressed the need to increase learners' access to environmental education field experiences and to link these outdoor activities to relevant curricula within the classroom [(7)]. To quantitatively assess the impact of environmental education on students, the key is to determine their environmental literacy; another research output exposed that environmental literacy is the main goal of environmental education. As part of environmental education, environmental literacy consists of the knowledge, awareness, behaviours, and environmental attitudes of everyone. This implied that cognitive knowledge, attitudes, and developing positive behaviors towards the environment must be implemented holistically and integrated [(8)]. A study on the environmental literacy of Indonesian students showed a direct correlation between ecological knowledge and increased thinking skills. A strategy implemented in their local environment problem-based learning through worksheets showed its effectiveness in increasing the environmental literacy of the learners [(9)]. The worksheets reinforce student environmental literacy regarding identification, analysis, evaluation, and planning actions attuned to global and local issues. Their result aligns with the environmental literacy of the US learners as assessed [(10)]. In Iran, a study on

environmental literacy of college students by Mendoza 2023 revealed that the students have a positive attitude and a high degree of concern and exhibited sensitivity to the environment. Still, they have a range of low to moderate degrees of environmental knowledge. A study on how environmental literacy integrates different variables, such as cognitive knowledge, environmental values, and ecological behavior, demonstrated that the link between knowledge types and behaviour is weak. On the other hand, the translation of environmental literacy to research and learning outcomes [11].

On the other hand, citizen science is about the dynamic action of ordinary people in scientific research. This is about the participation of the community in scientific research and knowledge production for global benefit [12]. Because of current environmental issues and problems, people are not vigilant, safeguarding, and monitoring the environment [13]. Citizen Science is a method to increase the participation of the community in public health research. This is about empowering citizens to take social actions to advance community health. Citizen science started in natural science fields. These include biology, meteorology, conservation, and ecology [14].

Citizen science is crucially important in today's setting; the participation of people in scientific research can enhance education and learning. There were dilemmas in integrating citizen science, such as competing scientific goals and learning outcomes, differing underlying ontologies and epistemologies, diverging communication strategies, and clashing values around advocacy and activism [15]. But properly incorporating the concept is required and recommended to make this predicament positive.

In the case of elementary levels, environmental literacy and citizen science are often part of the curriculum. Teaching learners at a very young age has been proven an effective strategy. Making learners aware of ideas, specifically science concepts, can bring positive results and improve attitudes towards science and technology. Through this, learners also better understand scientific procedures and conditions [16]. The correct formula for environmental literacy and citizen science is information. Providing better understanding can result in positive learning.

This study aimed to determine environmental literacy and citizen science capability among grade six learners in the schools along Tigum River in the Province of Iloilo, Philippines.

2 Methodology

The study employed a descriptive research design to collect, analyze, interpret, and write the results. The data were then analyzed and interpreted based on the information from elementary grade schools. The study participants included 29 elementary schools bordering the Tigum River basin in the Province of Iloilo, Philippines. Three-hundred-fifty learners were randomly selected as the participants of the study. The Tigum River is the water source, and fish provide transportation and other environmental services. In this light, the river ecosystem is a good content and context for environment-based education and a fertile ground for science subject enrichment areas, especially in the newly implemented K-12 curriculum in the country.

The Environmental Literacy Instrument was modified from the Middle School Environmental Literacy Survey Instrument in the United States. Another questionnaire was the researcher-made Citizen Science Capability Questionnaire. It was based on the various citizen experiences in various countries. The validity and reliability of the two instruments were established using the standard procedures. The instruments were subjected to face and content validation by seven jurors. The comments and suggestions were fully integrated into the final draft of the instrument. The final instruments were pilot tested in four elementary schools to those who were not the actual respondents of the study.

Permissions were secured from the Iloilo City Schools Division Superintendent and Schools Division Superintendent of Iloilo Province for pilot testing and validating the data-gathering instruments. When the approval was pushed through, a courtesy visit to the principals was made to arrange the schedule for administering the questionnaires to their respective grade six learners. The validated and reliability-tested data-gathering instruments were administered to 29 schools along the Tigum River basin.

The quantitative data were gathered from the learners' responses and then processed through the Statistical Package for the Social Sciences (SPSS version 21) software, which was used to create data files and process the results. Frequency count was used to ascertain the different profiles of the respondents as to their sex, school type, location, and type of curriculum. Percentages were used in computing the growth for the profile of the respondents on their corresponding distribution in the actual samples of the study and the possible points for each environmental literacy variable. Means were obtained from environmental literacy regarding the learner's ecological knowledge, verbal commitment, actual commitment, environmental sensitivity, general environmental feelings, and environmental issue identification skills. Also, means were applied to the computation on the level of citizen science capability of grade six learners in science, biodiversity, soil and water quality, and solid waste management. Standard deviation was used in the interpretation of the means to ascertain the scores' dispersion as to the learners' responses in terms of their environmental literacy and citizen science capability.

3 Results and Discussion

3.1 Descriptive Analysis of Ecological Knowledge

Table 1 shows the ecological knowledge of grade six learners when grouped into sex, school location, school, and curriculum types. The results of the surveys revealed that in terms of sex, school location, and school type, both groupings are classified at similar levels of having average environmental knowledge. Results on the objective questionnaire on ecological knowledge showed that based on sex, school type, and school location, their knowledge level is average (M=10.20; SD=2.89). However, there is a marked difference in the learners' achievement between the type of science curriculum offering regular (M=9.80; SD=2.82) and science class (M=11.87; SD=2.60).

One common problem in the K-12 Basic Education Program of the Department of Education (DepEd) is over content. Learners must learn many things in one setting. Hence, one suggestion is to make a robust strategy framework for positioning to address current gaps like the condition of our ecosystem [17]. Furthermore, hands-on activity in the ecosystem is one of the best ways to make students understand the environment. Making actual activities on the biotic and abiotic factors an effective strategy and approach [5]. Like in elementary, first-time activities could have a lasting impression on learners.

Table 1. The Ecological Knowledge of Grade Six Learners When Grouped According to Their Profiles

Category	SD	Mean	Description
Sex			
Male	2.96	10.25	Average
Female	2.87	10.18	Average
Total	2.89	10.20	Average
School Location			
Rural	2.84	10.84	Average
Urban	2.42	8.70	Average
Total	2.89	10.20	Average
School Type			
Public	2.86	10.24	Average
Private	3.20	9.87	Average
Total	2.89	10.29	Average
Science Curriculum Type			
Regular	2.82	9.80	Average
Special Science Class	2.60	11.87	High
Overall	2.89	10.20	Average

3.1.1 Verbal Commitment Analysis

The result in Table 2 shows that the level of verbal commitment is average (M=3.45, SD=0.70).

Table 2. Verbal Commitment of Grade 6 Learners to the Environment

Statements	SD	Mean	Description
1. I do not throw my garbage in the canal or river.	0.56	3.76	High
2. I turn off the faucet while I brush my teeth to save water.	0.55	3.73	High
3. I follow the rules and regulations on the environment.	0.59	3.72	High
4. I save energy by putting off lights when not in use.	0.71	3.70	High
5. I use less water when I bathe to save water.	0.63	3.55	High
6. I join the clean-up drive in the rivers and streets.	0.75	3.51	High
7. I separate my family's trash for recycling.	0.72	3.34	Average
8. I write slogans asking people to help reduce pollution.	0.68	3.31	Average
9. I ask people who do not recycle to start doing it.	0.87	3.31	Average
10. I use dimmer light bulbs to save energy.	0.77	3.19	Average
11. I stop buying charcoal to preserve our forest.	0.72	3.14	Average

Continued on next page

Table 2 continued

12. I walk in and go to school to reduce air pollution.	0.88	3.12	Average
Overall	0.70	3.45	Average

One of the best ways to make verbal commitment to make it more successful is to have teachers who are knowledgeable of the topics. They can only be nominal literate and environmentally aware through expertise in the topics; thus, one study suggests providing training and workshops on environmental education [6]. In the Philippines, elementary teachers are generalists. In addition, one study recommends using online learning in ecological systems. The learners were able to respond effectively during the interview [18].

3.1.2 Actual Commitment Analysis

Actual commitment is a pro-environmental behavior that refers to the performance of activities towards the environment. The items highlight tree planting, energy conservation, recycling, and other environmental care activities. As seen in Table 3, the actual commitment is on the average (M=3.25; SD=0.77) level.

Table 3. Actual Commitment of Grade 6 Learners to the Environment

Statements	SD	Mean	Description
1. I turn off lights at home when they are not in use to save energy.	0.69	3.71	High
2. I plant trees to prevent air pollution and flooding.	0.64	3.65	High
3. I turn off the faucet while I brush my teeth to conserve water.	0.61	3.61	High
4. I put off electric lights when not in use.	0.75	3.56	High
5. I ask my family to recycle some of the things we use.	0.65	3.51	High
6. I talk with my parents about how to help with environmental problems.	0.61	3.39	High
7. I do separate things at home for recycling.	0.77	3,39	High
8. I put up a garden in our homes.	0.81	3.33	High
9. I ask others what I can do to help reduce pollution.	0.72	3.31	High
10. I ask my parents not to buy charcoal to conserve our forest.	0.71	3.14	Average
11. I let water faucet run only when not in use.	0.97	1.66	Low
Overall	0.71	3.30	Average

3.1.3 Environmental Sensitivity Analysis

The overall sensitivity of the learners, as seen in Table 4, shows that it is on the average (M=3.25; SD=0.77) level. The environmental sensitivity component of environmental literacy shows that in 8 out of 10 questions, the learners responded with High (Large Extent). On the other hand, 2 out of 10 questions show Low (Small Extent) in the collection of wild animals in the forest and fish in the river and individual outdoor experiences.

Table 4. Environmental Sensitivity of Grade 6 Learners

Statements	SD	Mean	Description
1. To what extent are you environmentally sensitive?	0.82	3.36	High
2. To what extent your family is environmentally sensitive?	0.74	3.28	High
3. To what extent do you go camping with your groups or organizations (Boys or Girls Scouting)?	0.98	3.12	Average
4. To what extent do you enjoy watching TV shows, videos, CDs, DVDs, or internet? about nature and the environment?	0.92	3.12	Average
5. To what extent do you take part in activities such as going for walks, hiking, or bicycling?	0.90	3.10	Average
6. To what extent do you enjoy reading books or magazines about nature and the environment?	0.88	3.09	Average
7. To what extent do you take part in visiting grasslands, forests, or river?	0.93	2.97	Average

Continued on next page

Table 4 continued

8. To what extent do you take part in playing outdoors?	0.97	2.72	Average
9. To what extent do you spend time outdoor alone, not as part of a class or youth group?	0.99	2.45	Low
10. To what extent do you collect wild animals in the forest or fish in the river?	1.09	2.00	Low
Overall	0.77	3.25	Average

3.1.4 General Environmental Feelings Analysis

As seen in Table 5, most of the learners have a positive feeling toward the environment (M=1.13; SD=0.45). Conversely, they have low negative feelings towards the environment (M=1.13; SD=0.45).

Table 5. General Environmental Feelings of Grade Six Learners

Statements	SD	Mean	Description
1. I love the environment.	0.35	3.85	High
2. I hate the environment.	0.45	1.13	Low

3.2 Environmental Issue Identification Skills Analysis

Environmental issue identification skills of the learners are low, as seen in Table 6, which means that learners have less than 20% issue identification skills in the selection of charcoal making (M=0.39; SD=0.56) and strange bedfellows' selection (M=0.31; SD=0.56).

Table 6. Environmental Issue Identification Skills of Grade Six Learners

Environmental Issue Identification	SD	Mean	Description
Charcoal Making	0.56	0.39	Low
Strange Bedfellows	0.56	0.31	Low

3.2.1 Citizen Science Capability Among Grade Six Learners

The survey includes areas on science capability, biodiversity, soil and water quality, and solid waste management. These are capabilities that could contribute to a functional knowledge of science. The study results show that the learners can do citizen science projects (M=3.10; SD=0.86), as seen in Table 7. This means the learners have less than 80% but greater than 50% capability of doing citizen science projects. The science capability of the learners is based on their grasp of the scientific method. The learners can use evidence to reason and explain things (M=3.30; SD=0.81). This implies that the learners have a firm grounding in the power of using evidence in explaining things (M=3.30; SD=0.81). They have the lowest score in this category on interpreting data and generalizing. This is a challenge since the grade six learners must deepen their creative and critical thinking.

Table 7. Science Capability of Grade Six Learners

Statements	SD	Mean	Description
1. I use evidence to reason and explain things.	0.81	3.30	Capable
2. I gather data through my observations.	0.79	3.20	Capable
3. I participate in discussions involving scientific and environmental issues.	0.85	3.17	Capable
4. I interpret the meaning of models, graphs, charts or diagrams.	0.87	3.16	Capable
5. I record measurement readings in a notebook.	0.85	3.08	Capable
6. I tell whether the data is accurate or not.	0.88	3.01	Capable
7. I infer the meaning of data.	0.93	2.93	Capable
8. I interpret data and generalize out of it.	0.90	2.91	Capable
Overall	0.86	3.10	Capable

3.2.2 Citizen Science Capability on Biodiversity Analysis

The main species they observed are the birds, wherein they recruited millions of volunteers from the time they started a massive database was generated on the visual recording of birds present in each locality around the world. Since then, citizen science projects spread to plant and animal observation in different areas worldwide. The study results show that grade six learners can do citizen science projects in biodiversity (M=2.98; SD=0.90) as seen in Table 8.

Table 8. Citizen Science Capability of Grade Six Learners on Biodiversity

Statements	SD	Mean	Description
1. I determine the parts of the plants as root, stem, leaf, flower, spores, cones, or fruit.	0.78	3.31	Capable
2. I can tell whether an animal is an invertebrate.	0.79	3.30	Capable
3. I can classify plants as an herb, shrubs, vines, or trees.	0.78	3.27	Capable
4. I ask the help of my parents and elders in the community to identify the birds by local or common names.	0.80	3.22	Capable
5. I take photographs of the birds using a cellphone or camera.	0.85	3.20	Capable
6. I can identify plants as moss, fern, cone-bearing, or flowering.	0.88	3.17	Capable
7. I can take pictures of the plants through a camera, cellphone, or video.	0.83	3.17	Capable
8. I can tell the presence of birds in the rice fields or riverbanks.	0.85	3.10	Capable
9. I can identify plants by local or common names.	0.89	3.08	Capable
10. I can ask the experts or refer to field guides if the status of the plants is least concerning, vulnerable, threatened, or endangered.	0.91	3.04	Capable
11. I can document butterflies by photographing them with a cellphone or camera.	0.89	3.04	Capable
12. I can ask the help of the experts in telling whether the birds are migratory or not.	0.91	3.02	Capable
13. I can tell the presence of golden apple snails (kuhol) in the canals, rice paddies, or riverbanks.	0.92	2.94	Capable
14. I can observe grasshoppers and other insects in the school garden or riverbanks.	0.91	2.93	Capable
15. I can identify invasive species of fish present in the river.	0.88	2.93	Capable
16. I can tell the extent of the damage golden apple snail (kuhol) did to the rice plants.	0.88	2.93	Capable
17. I can collect plant samples in the garden or on riverbanks.	0.94	2.91	Capable
18. I can ask for the help of experts in identifying fish samples in the canals or rivers.	0.95	2.89	Capable
19. I can keep records of the plant's samples by pressing them.	0.92	2.87	Capable
20. I can provide bird-feeding devices in our homes.	0.94	2.87	Capable
21. I can collect and count the number of plants or animals in the locality.	0.89	2.84	Capable
22. I can monitor butterflies in the school garden or riverbanks weekly.	0.92	2.84	Capable
23. I can collect insect samples.	0.91	2.52	Capable
24. I can collect fish samples in the canals or rivers.	0.98	2.60	Capable
25. I can collect pollinating bee samples.	0.95	2.58	Capable
26. I can catch butterflies using nets without harming them.	1.30	2.52	Capable
Overall	0.90	2.98	Capable

3.2.3 Citizen Science Capability on Soil and Water Quality Analysis

The study results show that grade six learners can monitor water and soil quality inside the school campus or community areas. They obtained the M=2.94; SD=0.94 which is interpreted as capable of doing citizen science projects in determining water

and soil quality such as obtaining water samples in the canals, ponds, rainwater catchments, deep wells as well as rivers or sea waters in the beaches, Some water parameters that the school children can obtain are water pH, turbidity, dissolved oxygen, temperature, and in some cases the salinity of the water if the school is near the coasts, estuaries, or rivers that are affected by the ebbing and flooding of tides. In more sophisticated water analysis, if the laboratory is available, the learners can still explore the water quality, such as the bacterial load, and the chemistry of the water, such as the water hardness, and heavy metals analysis, which can give more comprehensive data on the overall water quality of a given sampling areas within or outside the school campus.

On the other hand, soil analysis can be monitored from rice paddies, school gardens, school campuses, or pots of plants grown in the school or homes. The routine soil analysis from agriculture and aquaculture ventures are fertile grounds wherein the learners can immerse or do their monitoring activities, especially in collecting available from farmers and aquaculturists alike. If the learners reside near farms, teachers can decide for them and let the school children visit the farms to gather the needed data for their assignments on the abiotic components of the ecosystems. The highest mean in the water and soil quality monitoring is the identification of the learners on the types of clouds present at a given time of the day in their own place (M=3.15; SD=0.91). The cloud monitoring activity is a good citizen project for schools. This could be translated to the cloud computing activity of the learners. The capability of the learners to identify whether the river's water is polluted (M=3.13; SD=0.89) ranked second. This indicates that learners have keen observational skills that could monitor the water quality in the river or pond ecosystems.

Table 9. Citizen Science Capability of Grade Six Learners on Soil and Water Quality

Statements	SD	Mean	Description
1. I can identify the types of clouds present in each time of the day in my own place.	0.91	3.15	Capable
2. I can tell whether the water in the river is polluted or not.	0.89	3.13	Capable
3. I can describe the color of the water in the river.	0.88	3.11	Capable
4. I can tell whether the water is silted or not.	0.87	3.01	Capable
5. I can point out the sources of pollutants in the canals or rivers.	0.89	3.00	Capable
6. I can collect soil samples for analysis in school garden, rice paddies, or riverbanks.	0.89	2.95	Capable
7. I can prepare and pack soil samples properly for analysis.	0.98	2.87	Capable
8. I can determine the temperature of the water samples in the river using a thermometer.	0.93	2.85	Capable
9. I can prepare water samples for laboratory analysis.	0.96	2.81	Capable
10. I can lay out sampling points for getting soil samples in riverbanks or school gardens.	1.12	2.81	Capable
11. I can air-dry soil samples taken from different sampling sites.	0.95	2.80	Capable
12. I can monitor rainfall using the rain gauge.	0.97	2,80	Capable
13. I can collect and identify solid wastes present in the river.	0.89	2.95	Capable
Overall	0.94	2.94	Capable

3.2.4 Citizen Science Capability on Solid Waste Management Analysis

The highest mean on solid waste management of the grade six learners is their capability to classify whether the waste is biodegradable or non-biodegradable (M=3.34; SD=0.90). The capacity to classify the type of waste is well entrenched in the learners' awareness. This is a very positive result wherein the learners are now ready to harness this capacity into a citizen science project wherein this skill can be channelled to translate this into the waste inventory. The data that can be gathered will inform our local leaders to enact an ordinance or enforce existing laws or ordinances. The second highest mean is the capability of the learners to reduce and recycle waste (M=3.23; SD=0.89). This is also a positive result wherein the learners are environmentally aware of their actions towards caring for the environment.

Table 10. Citizen Science Capability of Grade Six Learners on Solid Waste Management

Statements	SD	Mean	Description
1. I can classify solid wastes whether it is biodegradable or non-biodegradable.	0.90	3.34	Capable
2. I can reduce and recycle some solid wastes.	0.89	3.23	Capable
3. I can turn some waste into compost.	0.91	3.16	Capable
Overall	0.90	3.24	Capable

4 Conclusions

Environmental literacy among grade school learners in the Philippines gives impetus to the strategies and approaches in the curriculum on environmental education. The grade six learners' average to high performance in the assessment implies a strong delivery of content on the topics of environment. The delivery modality of environmental education in grade schools' points to the potent efficacy of science teachers to teach the subject matter that directly redounds to the learner's modest performance in the assessment tools. There is a direct link between environmental literacy and citizen science capability that learners can conduct environmental projects and research with the supervision of experts. This implies that learners' knowledge must be translated to environmental actions to be authentic and practical. The projects open the way for learners as constructivists that scaffold the competencies of expert teachers. Orchestrating literacy with capability helped the Department of Education to form an environmentally literate citizenry as mandated by DepEd. The constructivist theory is that learners learn efficaciously if the teachers have a firm grounding and command of environmental education content. Thus, the national government and other stakeholders support the call for localization and contextualization in teaching environmental science in elementary grades. Making learners aware of our local ecosystem teach them to become warriors to preserve and protect our environment. Also, further studies are recommended using all grade levels to assess learners' environmental literacy.

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