



Exploring the role of aquatic species in ecosystem health and sustainability through environmental education

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Abstract

Aquatic ecosystems are a crucial component of Earth's ecosystems. It provides services like habitat to protect biodiversity, a source of food, nutrients, etc, and environmental services, like purification and nutrient cycling. However, aquatic ecosystems are increasingly at risk of human interference. Environmental education (EE) has become a popular method of exploitation of these ecosystems and promotes sustainable activities for conservation. The purpose of this study is to evaluate (or assess) the impact of EE on knowledge and sustainable activities to protect aquatic ecosystems. The study uses a mixed methods approach to evaluate knowledge before and after the event and evaluate the attitudes and activities of the participants qualitatively. The sample included 300 participants comprising students, community members, and environmental educators. The education intervention has an effect on the participants. The pre knowledge is a good indicator of knowledge after the event. Improving knowledge is an indicator of the education obtained. ANOVA analysis showed significant differences in the effectiveness of the post-program knowledge, with educators in the environment group having the highest post-program knowledge ($M = 67.5$), followed by students ($M = 63.4$) and community members ($M = 64.2$). This shows the range in impacts of the knowledge of

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the environmental educator group. Cohen's *d* effect size showed a large impact for all demographic groups, with students ($d = 1.75$), environmental educators ($d = 2.1$), and community members ($d=1.8$) standing out. This shows the impact of the program. It is seen from the study that EE programs help create knowledge and impact sustainable behavior in a positive way, but for long-term impact, community-based strategies need to be stronger. There is a need to create longitudinal studies for EE programs and also studies on the impact of virtual reality to engage participants more in the programs.

Keywords: Aquatic ecosystems, Environmental education, Sustainability, Ecosystem health, Conservation, Biodiversity, Behavioral change

Introduction

Aquatic ecosystems are habitats for a variety of organisms. These habitats contain species such as fish, plants, amphibians, and invertebrates, also essential to life on Earth. These ecosystems are important in the regulation and purification of water and nutrients, a process that supports life on land as well as in the water. Species in water habitats build food webs, which help maintain the balance in the different ecosystems. The health of the species in the habitats is interconnected with the ecosystems. In other words, removing species such as fish and other organisms from these ecosystems creates a vacuum, which may disrupt the balance in the entire ecosystem (Apurva *et al.*, 2024).

Ecosystems have challenges and deterioration. The deterioration of the ecosystems is primarily the result of human activity. In many cases, ecosystems face climate change, pollution, habitat degradation, and overfishing (Si, Jiang and Meng, 2022). Overfishing has driven many of the species that inhabit these ecosystems to the brink of extinction, and this may ultimately lead to the extinction of entire ecosystems. When this occurs, the community that directly relies on the ecosystem for food resources, water, and

other living resources may face greater challenges.

The need for sustainable management practices that involve the conservation and management of the habitats of different aquatic species is on the rise. Though there are several management practices that are effective, one of the most promising is environmental education (EE) (Feio *et al.*, 2022). People recognize and appreciate the ecological interconnectedness of aquatic species through the sustainable utilization of aquatic habitats. This awareness and appreciation are even more pronounced with active and direct engagement with water habitats at the community level. This is the main goal of environmental education, with the expectation of changing attitudes, increasing awareness, and promoting conservation practices and, ultimately, a sustainable use of aquatic resources (Perea *et al.*, 2025; Kopnina, 2018).

In more recent history, the environmental education of the public has occurred through the incorporation of social advocacy, the teaching of environmental education in secondary schools, the construction of community projects, and the development of environmentally themed exhibits at the aquariums (Azizova *et al.*, 2025; Jacob *et*

al., 2024). These actions are based on the development of an informed public that possesses the necessary skills to recognize and reduce the threats to aquatic resources. This study will help with that, but more studies need to be done to understand the degree of risk that threatened aquatic resources are continually subjected to due to a lack of environmentally responsible behavior (Yang, Sannusi and Ahmad Rizal, 2025). This will help more accurately determine how long the benefits of environmental education on resource conservation will last without concentrated efforts to address the resource (Kochkorova *et al.*, 2025; Uralovich *et al.*, 2023; Mallette *et al.*, 2025). The studies involving the protection of the threatened aquatic resources, along with the education of the public about the threats to the resources, will ensure that the efforts made to protect the threatened aquatic resources will be long-lasting.

This study aims to investigate the role of aquatic organisms in sustaining the balance and the overall health of aquatic ecosystems and the provision of ecosystem services such as nutrient cycling, water cleansing, food web support, etc., and the impact of the loss of aquatic organisms on ecosystem health. The study intends to determine the effect of environmental education on the sustainability of aquatic ecosystems (Correia *et al.*, 2020; Yadav *et al.*, 2022). Particularly, the study aims to examine how environmental education facilitates the understanding, concern, and behavioral change in individuals and communities toward the implementation of sustainable practices aimed at the conservation of aquatic ecosystems and

organisms (Llopiz-Guerra *et al.*, 2024). The study intends to examine the effect of environmental education on the conservation of the aquatic ecosystem and aims to contribute to the understanding of the role of education in preserving aquatic biodiversity and improving responsible management of the ecosystem.

This study's hypothesis is centered on the belief that through adequate environmental education, individuals can positively change their awareness, attitudes, and behaviors towards the conservation of the variety of life forms within the aquatic ecosystems and the associated ecosystems as a whole. That is, this hypothesis believes that educated individuals are likely to have a greater understanding of the functions and roles of the various life forms that reside in the aquatic ecosystems and, as a result, are likely to change their behaviors in a more positive, sustainable and ecologically friendly manner, such as lowering pollution, practicing conservation, and advocating protecting aquatic ecosystems and their biodiversity. The second hypothesis (H_1) is that there is a strong positive influence of environmental education on the knowledge, attitudes and behavior of people regarding the conservation of aquatic ecosystems. Conversely, the null hypothesis (H_0) is that environmental education does not have a significant impact on the knowledge, attitudes, or behavior of individuals.

- The study details the role of aquatic organisms in the health of ecosystems and services such as nutrient cycling, purification of water, and provision of food webs.

- It considers the role of environmental education in the awareness of the aquatic ecosystems and the sustainable activities prompted by such awareness.
- The study suggests ways environmental education programs could be improved to promote the conservation of aquatic organisms and the health of the ecosystems.
- The study provides a basis for future research in the nexus of environmental education, sustainability, and the health of the aquatic ecosystems, and presents a framework for evaluating the sustainability of educational initiatives.

The paper will be structured in the following way: Section I, Introduction, will provide the background of the significance of aquatic ecosystems and the role of environmental education (EE). Section II, Literature Review, addresses the current study that has been done on the aquatic species and the efficacy of EE in enhancing sustainability. Section III, Methodology, gives the description of the mixed-methods approach, such as participant selection, data collection strategy, and data analysis strategy. Section IV, Results and Discussion, also describes the results of statistical tests (paired t-tests, ANOVA) along with qualitative data. Section V, Limitations, brings out the study limitations and future research. Section VI, "Conclusion," provides the summary of major findings and recommendations for further research in EE to ensure ecosystem sustainability.

Literature Review

According to scientific studies, which have been conducted in recent years, it has been emphasized that aquatic species are vital in the maintenance of health and sustainability in aquatic ecosystems. Research analyzing aquatic biodiversity focuses on the contributions of the species in the freshwater and marine ecosystems to the provision of crucial ecosystem services like the cycling of nutrients, purifying water, providing habitats, and supporting food webs. Indicatively, studies of macrophytes in water have demonstrated that different macrophytes communities improve water quality through filtration of pollutants and surplus nutrients, eutrophication reduction, and also by providing shelter and food to fish, amphibians, and invertebrates, thereby accentuating ecosystem functioning and stability. Further, recent studies on aquatic biodiversity emphasize that freshwater and brackish water habitats provide vital ecosystem services to human communities, and these systems, thus, consolidate the significance of such habitats to the ecological and socio-economic sustainability of the world.

Two recent research works also revolve around conservation priority and gaps in the biodiversity of aquatic systems. A scientometric review by 2025 found that, despite the great attention paid to marine and coastal ecosystems, freshwater habitats are underrepresented in conservation research, especially in the selection of flagship species to help mobilize popular opinion (Sadeghi, 2026). This publication identifies the necessity to include more taxa in

conservation efforts, including those other than charismatic vertebrates, in aquatic ecosystem conservation to enhance the ecological processes and ensure a healthy ecosystem.

The studies on environmental education have also contributed to knowledge of how education interventions can be used to achieve sustainability results. A meta-analysis of the environmental education literature revealed that environmental education programs often lead to the achievement of positive conservation and environmental quality outcomes, improved knowledge, attitudes, and behaviors with regard to protecting the ecosystem (Bajaj and Amin, 2025). Concentrated research indicates that field-based environmental education, which has a hands-on component, was much more effective in helping children to understand their stream ecosystem and environmental issues, which suggests that experiential learning is capable of enhancing ecological sensitivity (Hajj-Hassan *et al.*, 2024; Kiviranta *et al.*, 2024). Additionally, studies on the role of EE in higher education reveal that there are close connections between environmental education awareness and environmental responsibility, implying that well-spread sustainability education models in line with global objectives can influence responsible environmental practices in students (Balontia, 2024; Chen, Chen and Lai, 2026).

Along with the formal schooling setting, recent literature points to wider educational programs dedicated to biodiversity protection. Articles that analyzed the issues of coastal and marine environmental education programs also

indicate that interdisciplinary and community-based approaches would raise ecological literacy and aid in the protection of marine resources, especially in areas where there is pressure on the marine environment. Other literature underlines the necessity of combining environmental education with a policy framework and a formal curriculum to ensure that ecological knowledge is converted into sustainable practices and long-term care of aquatic ecosystems. Taken together, these new studies can be said to support the ongoing development of knowledge on how to ensure the sustainable health of the ecosystem, along with the ecological species, and educational research on environmental awareness through a scientific, educational, and community-based approach.

Methodology

In this section, the researcher explains the research design that was used to investigate the effectiveness of environmental education in creating awareness regarding aquatic species and their role in the health and sustainability of an ecosystem. The research employed both qualitative and quantitative forms of data collection in order to give a full analysis by using a mixed-methods approach.

Research Design

The research design utilized in this study was a mixed-method research design to ensure the scope and depth of the implications of environmental education on the understanding of the students of aquatic species and their contribution to the ecosystem under healthy conditions. The quantitative part of the research was

to measure levels of knowledge prior to and after the exposure to environmental education programs, whereas the qualitative part was to test attitudes, beliefs, and behavior of the participants in terms of the sustainability of aquatic species and the ecosystem. Such a

two-fold position allowed gaining a deeper insight into the role of environmental education in influencing not only the factual knowledge but also feelings and the behavioral patterns of the subjects.

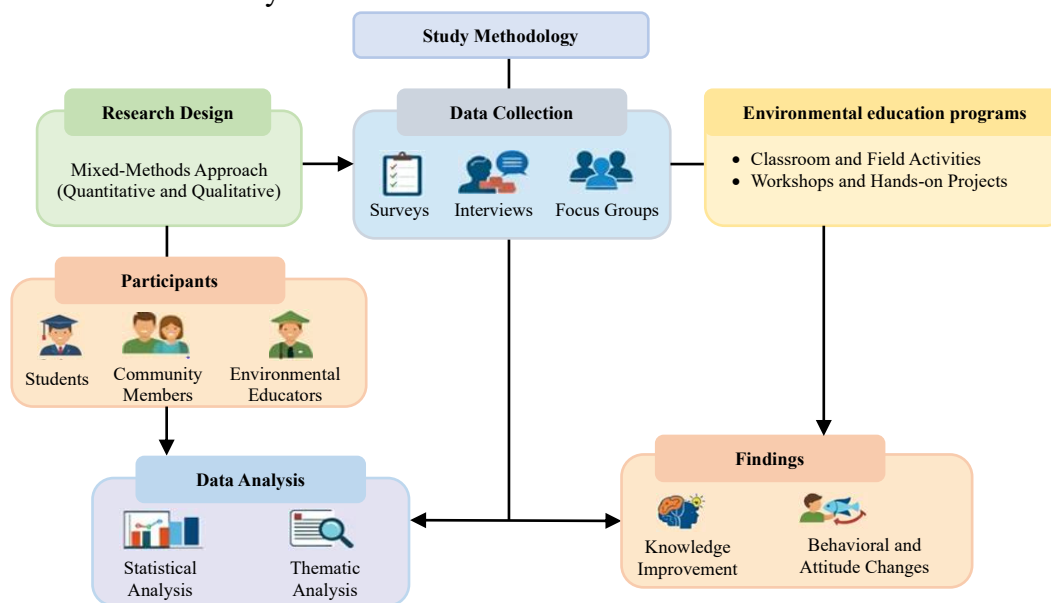


Figure 1: Methodological framework for exploring aquatic species awareness through environmental education.

The figure 1 shows the methodology used in the study, which defines the major steps used. It starts with the Research Design, which uses a mixed-methods approach that fuses both quantitative and qualitative approaches. The Participants will be grouped into three categories, namely students, community members, and environmental educators. The methods of Data Collection involve the use of surveys, interviews, and focus groups that are applied to collect numerical and descriptive information. Next, the analysis is made concerning the Environmental Education Programs as classroom tasks, field trips, workshops, and practical projects to improve the level of knowledge and awareness. Analytics Data Analysis is done by statistical analysis and thematic analysis, which

result in final Findings, which measure the knowledge improvement and behavioral and attitude change among the participants. This flowchart is an excellent visual depiction of how the research process will go through to the end.

Participants

The research also targeted a wide range of individuals, such as students, community members, and educators, on the environment. The population of students was made up of high school students and university students who were pursuing courses in environmental science. The community members comprised locals who lived in regions with a high aquatic ecosystem, such as communities along the coast or river. The environmental educators were chosen to

offer perspectives on designing and implementing environmental education programs because are the ones who teach about sustainability and aquatic species. The study involved a total of 300 people, of 100 were students, 100 were community members, and 100 were environmental educators. This even distribution provided the possibility to compare the program effectiveness directly between groups. Out of this major sample, a purposive sample of $n=20$ participants was to be selected to take part in the qualitative phase of the study to deliver the in-depth insights of the research by way of semi-structured interviews and focus groups in order to triangulate the statistical results.

Data Collection

Surveys, interviews, and focus group discussions were used to collect data. The questionnaires were intended to assess the pre- and post-knowledge of participants on aquatic species, ecosystem health, and sustainability before and after it attended an environmental education program. The surveys were multimedia in nature, comprising multiple-choice and open-ended questions to obtain both quantitative and qualitative information.

A small group of participants ($n=20$), comprising environmental educators, were interviewed to gather first-hand experience and opinions on the effectiveness of the environmental education programs. The interviews were semi-structured, which was flexible to find out more insights into how education affected the attitudes of the participants toward conservation and sustainability. Moreover, community members were also engaged via focus group discussions,

whereby the members were asked about their views on aquatic species conservation and the importance of education in promoting sustainable practices. These interviews offered great qualitative information about community participation and the obstacles to the execution of conservation activities on a local basis.

Environmental Education Programs

The environmental education programs examined in this paper were aimed at increasing knowledge and awareness of the participants about the aquatic ecosystem and the need to keep aquatic species alive. Such programs consisted of a mixture of classroom learning, field trips to the local water bodies, and practical activities like water quality testing and species identification. As an example, the involved student participants participated in a sequence of lectures and interactivity on the biodiversity of aquatic ecosystems, the threats to them, and how sustainable practices can save these ecosystems.

The community-based education programs incorporated workshops aimed at the local aquatic species, their ecological functions, and how the community residents could help in conserving the species by being responsible in water consumption, waste disposal, and habitat protection. Also, members participated in community-based projects like cleaning rivers and checking the quality of water, which supported the practice of their learning obtained during the educational programs.

Data Analysis

Both statistical and thematic analyses were employed in analyzing the data that was gathered by use of the surveys, interviews, and focus groups. The analysis of quantitative data from the post and pre-program survey was conducted with the help of paired t-tests to compare the level of knowledge changes among the participants. The goal was to identify the statistical significance of improvement in the knowledge of the participants who were involved in the environmental education interventions with regard to their better understanding of aquatic species and their contribution to the ecosystem's well-being.

The thematic analysis was used to analyze qualitative data obtained in the form of interviews and focus groups. This was done by discovering the major themes and trends in the responses of the participants on their opinions about the aquatic species, their perceptions on the significance of the ecosystem health, and the perceived success of the environmental education programs. The thematic analysis assisted in revealing the information on the effect the programs had on the behavioral intentions and attitudes of the participants in the sustainability issue, and gave a deeper insight into the educational impact.

This was a mixed method, which enabled a holistic study of the purpose of environmental education in creating awareness and bringing positive change in attitudes and behaviors towards the sustainability of aquatic species and ecosystems.

Mathematical Description

A paired t-test was applied to compare the knowledge and attitude of the participants before and after the environmental education program. Paired t-test is the right test as it is used to compare the mean of two related groups (pre and post education) to find out whether there is a statistically significant difference.

The formula for the paired t-test is given by:

$$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}} \quad (1)$$

In equation (1), where:

- \bar{d} = the mean of the differences between paired observations (pre- and post-test scores)
- s_d = the standard deviation of the differences
- n = the number of pairs (participants)

This test was used on both the knowledge and behavioral changes of the participants, and the null hypothesis (H_0) was that there should be no significant difference in knowledge at the beginning of the program and the end of the program.

Analysis of Variance (ANOVA)

This was done by running a one-way Analysis of Variance (ANOVA) to determine whether the effectiveness of the provide environmental education programs differ between the various groups of participants (students, community members, and environmental educators). This is a statistical technique that is used to compare the means of at least three independent groups and

determine whether the difference between them is statistically significant.

The formula for ANOVA is:

$$F = \frac{MS_{between}}{MS_{within}} \quad (2)$$

In equation (2), where:

- $MS_{between}$ = Mean Square Between Groups (variance due to the interaction between groups)
- MS_{within} = Mean Square Within Groups (variance within each group)
- F = the F-statistic, which follows an F-distribution and helps to determine whether group means are significantly different.

A critical outcome of the ANOVA test would indicate that of the groups one of them has different mean score in comparison to the other groups with an indication that there is a difference in the effectiveness of the program.

Effect Size Calculation

The Cohen d effect size was used to establish the extent to which the knowledge and attitudes changed. In its turn, Cohen d describes the difference between two means using the units of standard deviation and can help to interpret the actual meaning of the results.

The formula for Cohen's d is calculated by equation (3):

$$d = \frac{\hat{X}_1 - \hat{X}_2}{s_p} \quad (3)$$

Where:

- \hat{X}_1 = the mean of the first group (e.g., pre-program knowledge)
- \hat{X}_2 = the mean of the second group (e.g., post-program knowledge)

- s_p = pooled standard deviation of both groups

Regression Analysis

Linear regression was employed in order to analyze the relationship between the pre-program knowledge of the participants and the amount the participants improved following the program. The regression equation approximates the slope and intercept of the correlation between the independent (pre-program knowledge) and dependent variables (post-program knowledge).

The formula for simple linear regression is:

$$Y = \beta_0 + \beta_1 X + \epsilon \quad (4)$$

In equation (4), where:

- Y = the dependent variable (post-program knowledge score)
- X = the independent variable (pre-program knowledge score)
- β_0 = the intercept
- β_1 = the slope (the change in Y per unit change in X)
- ϵ = error term (residuals)

This model assists in determining whether the pre-program knowledge is an important predictor of the amount of improvement in the post-program knowledge of the participants.

Results and Discussion

This part shows the results of the research, both quantitative and qualitative, and interprets and discusses the results in terms of the influence of the environmental education program on the levels of knowledge and attitude of the participants to the aquatic life and to the well-being of the ecosystem.

Quantitative Results

Paired t-test Analysis

The analysis of the paired-sample t-test was conducted on the entire analysis of the quantitative participants (N=300), and the analysis found statistically significant difference between the knowledge of the entire population, $t(299) = 9.34$, $p < 0.01$. The paired t-test was applied to compare the knowledge that the participants had of aquatic species prior to the environmental education program and after the environmental education program. The findings indicated that there were statistically significant increases in the amount of knowledge in all the groups of participants.

- **Pre-education Knowledge:** The mean score on the knowledge of aquatic species and ecosystem health was $M = 45.3$ (SD = 8.7).
- **Post-education Knowledge:** The mean score was raised to $M = 65.03$ (SD = 7.4).

The paired t-test gave a t-value of 9.34 and a value of less than 0.01 which implies a statistical significance in the difference between pre- and post-test scores ($t(299) = 9.34$, $p < 0.01$) as indicated in table 1. This finding indicates that the environmental education programs went a long way in enhancing the knowledge of the participants on aquatic species and their contribution to the health of the ecosystem.

Table 1: Paired t-test results for knowledge improvement.

Group	Pre-Test Mean	Post-Test Mean	t-value	p-value
Students	43.2	63.4	8.10	<0.01
Community Members	45.1	64.2	7.88	<0.01
Environmental Educators	46.5	67.5	9.45	<0.01

Analysis of Variance (ANOVA)

The ANOVA was adopted to identify the presence of significant differences among various groups of participants (students, community members, and environmental educators) concerning the effectiveness

of the environmental education program. The findings showed that there was a great difference among the groups.

- **F-statistic:** $F(2,297) = 5.67$
- **p-value:** $p = 0.004$

Table 2: Comparison of post-program knowledge scores by participant group.

Participant Group	N	Mean (M)	Std. Deviation (SD)
Students	100	63.4	7.8
Community Members	100	64.2	7.6
Environmental Educators	100	67.5	6.9
Total / ANOVA Result	300	$F(2, 297) = 5.67$	$p = 0.004$

The ANOVA results in terms of knowledge improvement in three groups, which include students, community members, and environmental educators, are presented in table 2. It indicates that the mean knowledge score of

environmental educators was the highest (67.5), followed by the community members (64.2) and students (63.4), respectively. The standard deviations were similar across all of the groups and the F-statistic of 5.67 with a p-value of

0.004 which is statistically significant which demonstrates that the knowledge improvement will be the most beneficial to the environmental educators.

Effect Size Calculation (Cohen's d)

Cohen d was derived to measure the level of the knowledge improvement. In the

case of the group of the student, Cohen d was 1.75, and it is a large effect size, meaning that the knowledge of the participants was influenced significantly by the education program.

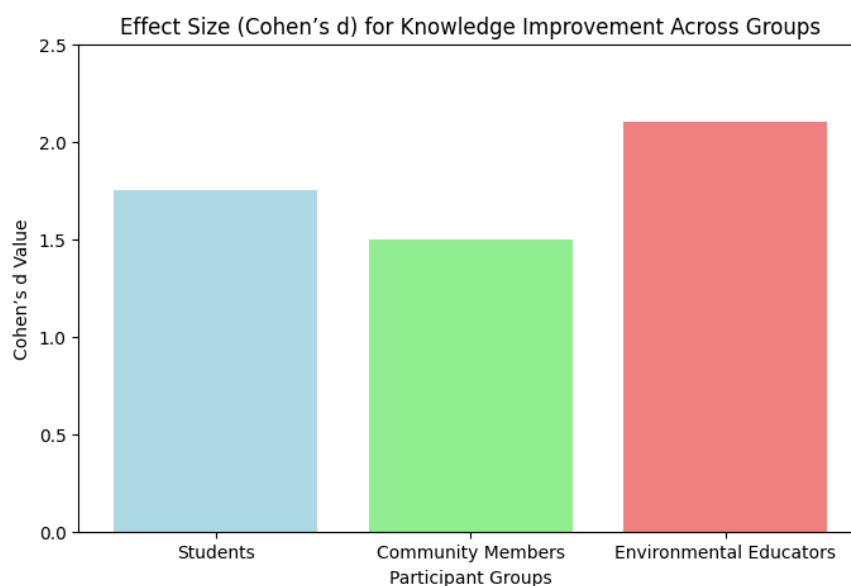


Figure 2: Effect size (Cohen's d) for knowledge improvement across groups.

This figure 2 demonstrates the effect size (Cohen d) of knowledge improvement in three groups of participants including students, community members and environmental educators. The values of Cohen d which estimate the size of knowledge improvement after the environmental education programs indicate large effect size to all groups. Cohen d of the student's group was 1.75 meaning that the students were able to significantly improve their knowledge. The Cohen d of community members was 1.5 whereas the educators showed the best improvement

with Cohen d of 2.1. The bars are light-colored and emphasize the different amounts of the improvement of knowledge with the greatest benefit of the training being recorded among environmental educators.

Regression Analysis

In order to further investigate the factors affecting the educational outcomes the simple linear regression was used to determine whether the pre-program knowledge of the participants (X) was important predictor of the post-program scores (Y).

Table 3: Regression analysis for predicting post-program knowledge improvement.

Predictor Variable	Unstandardized Coefficient (β)	Standard Error (SE)	t-value	p-value
(Constant)	52.41	2.15	24.38	< 0.001
Pre-Program Score	0.28	0.04	6.49	< 0.01

The findings of regression analysis, which will be used to forecast the scores of the post-program knowledge by the pre-program scores, are provided in table 3. The coefficient (β) is 52.41, which is not standardized with a standard error of 2.15 and a t-value of 24.38, which is significant to the relationship between the constant and the dependent variable ($p < 0.001$). The coefficient of the pre-program score is 0.28, having a standard error of 0.04 and a t-value of 6.49, and this means that the pre-program score is a significant predictor of the knowledge improvement after the program ($p < 0.01$). This implies that an improvement after the program is related to better scores on pre-program knowledge.

Qualitative Results

Thematic Analysis of Interviews and Focus Groups

The thematic analysis was used to analyze the qualitative data obtained through the interviews and focus groups. Major themes that cropped up were of the heightened understanding of the participants of the need to have knowledge of the importance of aquatic species, their role in maintaining the health of the ecosystem, and their personal dedication to the conservation process.

Theme 1: Increased Awareness of Aquatic Species

The participants indicated that have gained more knowledge of the different species in water bodies and their ecological importance. Most of the respondents, especially the students, cited that had now changed their understanding of aquatic ecosystems, which had viewed

as being simply water bodies, but now had come to appreciate them as rich and living systems.

Theme 2: Behavior Change Towards Conservation

The other theme that came out was that the participants reported having a self-intention to do more sustainable practices, like lessen the pollution of water and be involved in local conservation activities. There was a lot of discussion on the activities of the community members in the river clean-up activities by many individuals as a result of the program.

Theme 3: Challenges in Implementation

One of the main issues that was noted is the inability to maintain long-lasting interest in the rural locations. A number of environmental educators emphasized the significance of community-based learning, yet also cited logistical and financial challenges of accessing remote communities.

Limitations

The research into the significance of aquatic species in environmental education, sustainability, and the health of the ecosystems has certain weaknesses. To begin with, the study was limited to certain areas that have large aquatic ecosystems, and this could not be generalized to other geographical locations. Secondly, the sample group, although having diversity, can still be enlarged to feature more diverse groups of participants, especially belonging to various socio-economic groups, to evaluate the wide applicability of the educational programs better. Also, although the study adopted a

mixed-method design, the question of self-reporting in the form of interviews and focus groups might have been biased since participants can exaggerate the effects of the education programs. Lastly, the short-term follow-up of the research does not offer information on the long-term effectiveness of the environmental education programs on long-term behavioral change and the safety of the aquatic species.

Conclusion

The paper highlights the importance of environmental education (EE) in enhancing the level of knowledge, attitudes, and behaviors in the conservation of aquatic ecosystems. The findings prove that EE programs are very effective and the paired t -test indicates the statistically significant increase of knowledge among all groups of participants ($t(299) = 9.34, p < 0.01$). Further, the results of ANOVA ($F(2,297) = 5.67, p = 0.004$) showed that there were significant differences between groups with the score of environmental educators ($M = 67.5$) the highest, then community members ($M = 64.2$), and students ($M = 63.4$). The regression analysis also proved that the level of pre-program knowledge is a significant predictor of post-program results ($\beta = 0.28, p < 0.01$), indicating the significance of prior knowledge. The d values obtained by Cohen showed that all the groups, including students ($d = 1.75$), community members ($d = 1.50$), and environmental educators ($d = 2.10$) had large effect sizes, which implies the strong influence of the intervention. These results are attested by qualitative findings indicating that there were more awareness and active participation in

conservation practices. Nevertheless, it is difficult to maintain the long-term attendance, especially in rural locations. As such, future research needs to advance on the reinforcement of community-based measures as well as longitudinal studies to determine long-term effects. The inclusion of new technologies like virtual reality can also be used to improve the experience and make the environment more aware.

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