JOURNAL OF INTERDISCIPLINARY PERSPECTIVES

ISSN Print: 2984-8288, ISSN Online: 2984-8385
Vol. 3 No. 6, pp. 201-215, June 2025

Gleaning Fisheries as Context for Culturally Relevant Contents for Science Teaching

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Date received: April 3, 2025
Date revised: April 22, 2025
Date accepted: May 16, 2025

Originality: 95%
Grammarly Score: 99%
Similarity: 5%

Recommended citation:
Garlan, M. (2025). Gleaning fisheries as context for culturally relevant contents for Science teaching. *Journal of Interdisciplinary Perspectives*, 3(6), 201–215. https://doi.org/10.69569/jip.2025.217

Abstract. This exploratory-sequential study investigates the integration of indigenous knowledge from a Philippine gleaning fishery into science education to contextualize curriculum content and enhance socio-cultural relevance and environmental consciousness. Thematic analysis revealed five key domains of indigenous science: fisheries management, religion, health, conservation biology, and earth science, each offering connections to socio-scientific and environmental issues. A prototype lesson plan was developed based on these themes and underwent pilot testing with 60 participants (30 teachers and 30 students) from a coastal community engaged in gleaning activities. Results showed a moderate acceptance among students (M = 2.99, SD = 0.486) and a high level of acceptance among teachers (M = 3.95, SD = 0.486), as measured using a 4-point Likert scale. The findings underscore the pedagogical value of indigenous knowledge in fostering scientific thinking, environmental stewardship, and culturally responsive teaching. Embedding cultural practices into science instruction empowers educators to create inclusive, meaningful, and contextually grounded learning environments.

Keywords: Contextualization; Culturally relevant teaching; Gleaning fisheries; Indigenous science; Lesson plan; Science pedagogy.

1.0 Introduction

The science curriculum in the Philippines places a strong focus on community involvement and localized teaching, aiming to build on students' existing knowledge and cultural experiences (Buenvenida, 2015). Culturally relevant pedagogy (CRP) plays a significant role in increasing student interest by weaving cultural beliefs, traditions, and lived experiences into science instruction, which helps learners grasp scientific ideas more effectively and see their relevance in everyday life (Handa, 2008; Hammond, 2001; Moll, 1992). Aligned with this approach, the Enhanced Basic Education Curriculum requires schools to adapt learning materials and methods to reflect the cultural and social realities of their local communities, a mandate supported by Section 14, Article XIV of the 1987 Philippine Constitution and reinforced by Republic Act No. 10533 or the Enhanced Basic Education Act of 2013 (Pearl, 2015). Through the K–12 reform, science education aims to improve both scientific understanding and practical skills by relating content to the lived experiences of Filipino students. Nevertheless, effectively applying CRP remains a challenge, particularly when designing teaching strategies that suit diverse cultural settings. Science educators are therefore encouraged to identify and integrate culturally embedded knowledge from their students' environments to enrich classroom instruction. This includes drawing on the scientific aspects found in everyday household practices and community traditions. Research highlights the effectiveness of CRP in the Philippine context; for example, culturally responsive teaching tools such as documentaries and personal reflections have been used to support the educational needs of indigenous communities like the Iraya Mangyan, fostering a more inclusive and culturally sensitive learning environment (Bawagan, 2010). Similarly, Brown and Cooper (2011) argue for

integrating students' cultural values and experiences into science instruction to support the holistic goals of the K–12 curriculum.

In response to the marginalization of indigenous perspectives, Pejaner and Mistades (2020) highlighted the cultural disconnect experienced by the Obo Monuvu tribe and advocated for curriculum revision to address indigenous realities. Inocian et al. (2020) proposed the Inasal Teaching Model (ITM), which draws from Cebuano cultural identities to design culturally grounded instruction. Meanwhile, Snively and Corsiglia (2000) emphasized the educational significance of traditional ecological knowledge (TEK), calling for its integration into science curricula to recognize multiple ways of knowing. Pawilen (2023) further demonstrated the value of localized and community-based curricula in early science education, advocating for integrating indigenous knowledge, cultural scripts, and local resources to foster children's interest in science.

This study responds to the pressing need for a culturally relevant and context-specific approach to science education in the Philippines. Recognizing the limitations of conventional teaching methods in addressing learners' diverse cultural contexts, this research aims to bridge the gap between indigenous knowledge and mainstream science curricula. It explores the scientific dimensions of gleaning fisheries—an enduring livelihood practice in coastal communities—and investigates how these practices can inform science instruction through a culturally grounded lens. Employing a thematic analysis, the study systematically extracted scientific themes embedded in gleaning practices to develop a lesson plan exemplar rooted in indigenous science. This lesson plan was designed to align with the indigenous knowledge systems and the scientific competencies outlined in the national curriculum. The resulting instructional framework offers a model for integrating traditional ecological knowledge into science education, highlighting the educational value of indigenous wisdom while maintaining consistency with formal science standards.

This study addresses the broader call for inclusive science education by contributing a culturally responsive instructional model. It affirms the importance of recognizing indigenous knowledge as a legitimate and valuable source of scientific understanding. It aims to serve as a reference for educators and policymakers seeking to develop science curricula reflecting learners' cultural diversity in the Philippines and the broader Asian region.

Indigenous Science and Cultural Identity

Indigenous science is necessary for developing Filipino learners' scientific knowledge, attitudes, and process skills while preserving their cultural identity. Indigenous knowledge taught and practiced by community folks includes predicting weather conditions, traditional herbal medicine, preserving and selecting good seeds for planting, and native fruit winemaking. Indigenous science is practiced by different groups of people and early civilizations (Sibisi, 2004). According to Pawilen (2021), indigenous science includes complex arrays of knowledge, expertise, practices, and representations that inform human societies in their interactions with the natural milieu: agriculture, medicine, naming and explaining natural phenomena, and strategies for coping with ever-dynamic environments. Ogawa (1995) also emphasized that indigenous science is experienced and collectively lived in by the people of a given culture. Indigenous science also develops essential values relevant to scientific attitudes, such as motivating attitudes, cooperating attitudes, practical attitudes, and reflective attitudes (Johnson, 1992). Sibisi (2004) underscored that indigenous science provides the basic foundations of astronomy, pharmacology, food technology, and metallurgy derived from traditional knowledge and practices.

Culturally Relevant Education and Pedagogy

Culturally relevant education is discussed here, emphasizing teaching strategies aligned with cultural knowledge, culture-based curricula, and community participation in education. Culturally relevant pedagogy is presented as a new way of teaching that embraces students' customs, traditions, and home worlds. Culture is recognized as an essential part of people's lives, consisting of behavioral patterns, symbols, and institutions, including schools. Demmert and Towner (2003) stated that culturally relevant education includes teaching strategies parallel to cultural knowledge, including culture-based curricula, and involves community participation in educating children. Hammond (2001) and Moll et al. (1992) emphasized that culturally relevant pedagogy is a new way of seeing the world in a way that teachers can teach their lessons while embracing their students' customs, traditions, and home worlds. Banks (2001) believes that culture is an essential part of people's lives, consisting of behavioral patterns, symbols, and institutions, which includes a school as an institution and the students in the school.

Funds of Knowledge and Context-Based Science Curriculum

Funds of knowledge are identified as valuable resources for academic instruction in science. The knowledge and skills gained from these cultural interactions are known as funds of knowledge (Moll et al., 1992), and this knowledge could form a basis for curricular units in science. Genzuk (1999) considered funds of knowledge as an underdeveloped resource for academic instruction that teachers can provide with cultural congruence. Studies of Hispanic students and teachers showed that funds of knowledge are diverse in children because they actively participate in diverse community activities (Moll et al., 1992). Funds of knowledge can be used in teaching to engage teachers in critical pedagogy based on students' resources (Gonzales et al., 1992). When teachers are connected to the sources of students' funds of knowledge, classroom instruction tends to be less transformative and participatory (Moll et al., 1992).

Gleaning Fisheries as Context to Identify Science Contents

The study aimed to glean indigenous science in Guimaras Island in the Philippines, and used the knowledge to identify science contents for context-based and culturally relevant science curriculum framework. *Pagpanginhas* is a native Filipino term that translates to gleaning fisheries. It is one of the many cultural practices in the Philippines and is considered one of the locality's primary livelihood sources. It is carried out in the intertidal zone when the low tide is at its maximum, and the marine species collected include mollusks, echinoderms, and other invertebrates of commercial importance. The often-overlooked practice of intertidal gleaning, a type of small-scale fisheries (SSF), significantly contributes to bolstering food security and augmenting income within fishing communities (Cullen-Unsworth et al., 2014; Grantham et al., 2021; Villarta et al., 2021; Estrada et al., 2021; Stiepani et al., 2022; Treviño, 2022). This form of small-scale fisheries encompasses diverse collection activities, including gathering algae and various invertebrates such as mollusks, echinoderms, or crustaceans. (Andréfouët et al., 2013; Tilley et al., 2021; Stiepani et al., 2022; Anderson et al., 2023). Collectors or gleaners, whether opportunistic or focused on particular species, traverse the shoreline, intertidal zone, or submerge themselves during low tide to gather resources (Grantham et al., 2021; Tilley et al., 2021a; Bantayan, 2022; del Norte-Campos et al., 2023). In contrast to freely swimming fish, the species gathered in intertidal gleaning are visible and easily collected by hand. This accessibility makes it a feasible practice for individuals lacking the skills or equipment required for conventional fishing (del Norte-Campos et al., 2005; Furlong et al., 2020).

The diverse collection activities in intertidal gleaning involve various species of algae and invertebrates. Studying the gathered species provides insights into the biodiversity of intertidal zones and the ecological relationships between different marine organisms. The ability of collectors or gleaners to gather resources during low tide highlights the adaptations of marine organisms to intertidal environments. Understanding how marine organisms adapt to fluctuations in water levels and exposure to air provides valuable information about their physiological and behavioral adaptations. Intertidal gleaning involves individuals traversing the shoreline to collect resources. Examining the interactions and interdependencies among different species and individuals engaged in intertidal gleaning contributes to understanding community ecology within coastal ecosystems. The practice of intertidal gleaning for food and income raises questions about the sustainability of this small-scale fishery. Studying the impact of intertidal gleaning on targeted species and the overall ecosystem helps assess the sustainability of this practice and informs strategies for responsible resource management. Intertidal gleaning involves the collection of various marine organisms, including mollusks, echinoderms, and crustaceans. Researchers can study the taxonomy, life cycles, and ecological roles of the collected organisms, contributing to the broader field of marine biology. The accessibility of intertidal gleaning makes it feasible for individuals lacking conventional fishing skills or equipment. Understanding the social and cultural aspects of intertidal gleaning, including the knowledge and practices of gleaners, contributes to the broader field of social sciences within the context of fisheries management.

These literatures reflect the interconnectedness of indigenous knowledge, culturally relevant education, and the integration of funds of knowledge into science curricula, emphasizing the importance of preserving cultural identity while fostering scientific understanding.

2.0 Methodology

This study investigates one of the five significant cultural practices in a Guimaras Island, Philippines coastal community, specifically focusing on the indigenous knowledge embedded in gleaning fisheries. The research

adopts an exploratory-sequential mixed methods approach, a robust methodology that integrates qualitative and quantitative techniques. This approach allows for the comprehensive exploration of indigenous knowledge and its subsequent translation into a culturally relevant science curriculum to enhance the local educational experience. The research framework is grounded in the epistemology of constructivism, emphasizing the co-creation of knowledge within social contexts. Symbolic interactionism is the theoretical lens that provides insight into the dynamic interplay between cultural behaviors and their symbolic meanings in the community.

The study is structured into two phases: the first entails collecting qualitative data from key informants. In contrast, the second phase involves developing and evaluating a culturally contextualized lesson plan aligned with the Philippine K-12 science curriculum. The key methodological steps are outlined below:

Exploration of Indigenous Science from Gleaning Fisheries

The primary objective of this research was to explore indigenous science within the context of gleaning fisheries, using Spradley's (1979) Developmental Research Sequence (DRS) for thematic analysis. The DRS framework is a well-established qualitative research method that involves systematic data collection, categorization, and analysis. This methodology was complemented by a negotiated agreement approach for validation, incorporating consensual coding techniques as Garrison et al. (2006) demonstrated. In addition, a thorough literature review was conducted, utilizing reputable platforms such as ScienceDirect and peer-reviewed articles, to ensure a comprehensive foundation for integrating indigenous science with formal education.

Selecting a domain. The study focused on extracting indigenous knowledge from gleaning fisheries, recognizing its significance as a source of traditional wisdom and environmental knowledge. The identified knowledge was a foundation for developing a culturally relevant curriculum framework. This framework aimed to bridge the gap between local practices and mainstream education, providing students with a more contextualized and culturally sensitive educational experience.

Selecting an informant. Purposive sampling was employed to select key informants—adults aged 35 and above and their children—who were actively engaged in gleaning fisheries (locally known as *pagpanginhas*). These individuals were selected based on their direct involvement in the practice, ensuring the information gathered was authentic and deeply rooted in the community's lived experience. Furthermore, 30 science teachers and 30 students were included in evaluating the lesson plan exemplar, providing additional insights into integrating indigenous knowledge into the science curriculum.

Choosing a locale. Barangay Dolores, located in Nueva Valencia, Guimaras, was selected as the study site due to its predominantly coastal population deeply engaged in gleaning fisheries. This locale was chosen because of its rich tradition of gleaning as a primary livelihood and its relevance to the study's focus on indigenous knowledge systems.

Learning the language. Hiligaynon, the regional dialect spoken in Western Visayas, was identified as the language of the community. The researcher invested significant time and effort to understand local terminology related to gleaning fisheries, such as *ugsad* (full moon), which provided a deeper understanding of the community's cultural and environmental context. This linguistic preparation was essential for fostering effective communication and ensuring cultural sensitivity in data collection.

Informant's perspective. The researcher employed participant observation to gain a comprehensive understanding of the community's worldview. This approach allowed for immersive engagement in the daily activities of the gleaning fisheries community, facilitating a deeper insight into their practices, beliefs, and cultural significance. This ethnographic method provided a nuanced understanding of how knowledge is situated within social and cultural contexts.

Asking descriptive questions. Descriptive questions were formulated to elicit detailed participant information about their experiences with gleaning fisheries. These questions were designed to uncover the contextual, cultural, and environmental elements that shaped the community's approach to gleaning and how these could be translated into science education.

Sampling. The study utilized purposive sampling to select a representative sample of participants involved in gleaning fisheries. Key informants included adult community members (aged 35 and above) and their children, ensuring that both generations' perspectives were captured. The study sample comprised 60 participants, split evenly between teachers (n=30) and students (n=30), providing valuable feedback on the lesson plan exemplar.

Thematic, Taxonomic, and Componential Analysis

Domain analysis. The thematic analysis identified a central domain—indigenous science in gleaning fisheries—underpinning the curriculum framework. The thematic analysis revealed key elements of local wisdom, traditional practices, and community values, which are represented in a visual domain model. This model comprehensively represented the interconnectedness of cultural practices and scientific knowledge, forming a coherent foundation for the culturally relevant curriculum.

Taxonomic analysis. Taxonomic analysis explored the relationships between different socio-scientific themes, including fisheries, religious practices, taxonomy, conservation biology, and astronomy. This analysis mapped indigenous knowledge to scientific principles, uncovering meaningful connections that could inform science education. The research also explored how these themes align with existing curriculum standards and proposed ways to integrate them into formal education.

Componential analysis. This step focused on analyzing the relationships between components within each thematic category, identifying variations, similarities, and contrasts. The analysis aimed to uncover the underlying structures of indigenous knowledge related to gleaning fisheries and assess its alignment with the science competencies prescribed by the K-12 curriculum.

Cultural theme analysis. Cultural theme analysis synthesized the findings from the previous analyses to identify overarching cultural patterns that emerged from the community's understanding of gleaning fisheries. These cultural themes were critical in framing the lesson plan and ensuring cultural relevance.

Writing ethnography. The final step involved writing an ethnographic account that effectively communicated the cultural meanings inherent in the indigenous knowledge of gleaning fisheries. This process included both linguistic translation and a rich portrayal of the symbolic and contextual significance of the practices observed. The ethnography bridges cultural gaps, ensuring the community's knowledge is accurately represented and communicated to diverse audiences, including educators, students, and policymakers.

Integration of Indigenous Knowledge into the K-12 Science Curriculum

The study thoroughly reviewed the Philippine K-12 science curriculum, identifying opportunities for integrating local wisdom, sustainability values, and environmental awareness derived from indigenous science. The curriculum analysis provided a framework for understanding how indigenous knowledge can be seamlessly incorporated into science education, fostering a more inclusive, relevant, and meaningful educational experience for students in coastal communities.

3.0 Results and Discussion

The study explored indigenous scientific principles and knowledge in gleaning fisheries, analyzing extensive data. Key insights were used to develop a context-specific lesson plan exemplar, aligning with educational standards and cultural contexts and ensuring seamless integration of indigenous knowledge. Table 1 on gleaning fisheries was used to identify relevant indigenous knowledge consistent with the mainstream science curriculum. The identified topics were then used as bases for developing contextualized, culturally-relevant lesson plan exemplars. The themes extracted from the practice of gleaning fisheries served as a rich source of science concepts that seamlessly aligned with the standard competencies outlined in the Philippines' science curriculum. By deriving scientific content from the cultural practice of intertidal gleaning, the lesson plan became inherently contextualized and, as a result, culturally relevant. This integration ensures that science teaching becomes academically rigorous but also meaningful and specific to the local context. The contextualized lesson plan offers students a unique opportunity to engage with scientific concepts in a way that directly resonates with their cultural experiences,

fostering a deeper understanding and appreciation for the subject matter. Overall, the approach enhances the effectiveness of science education and contributes to the preservation and promotion of local cultural practices.

Table 1. *The Five Themes Related to Socio-Scientific and Environmental Issues, Including Fisheries, Religion, Taxonomy, Conservation Biology, and Astronomy, and the Indigenous Knowledge Parallel to Scientific Knowledge and the Suggested Science Curriculum*

Cultural Practice	Ethnography
Gleaning fisheries	Within the gleaning fisheries community, seasoned and veteran fishing folks carefully gather various commercially prized shellfish species, including *sihi, baka-baka, sigay, sikad-sikad, tirik*, and *sobra-sobra*. However, they also avoid certain mystifying zones, known as *mari-it*, which are considered marine sanctuaries. The gleaning fishing folks carefully select mollusks and other marine species with vibrant hues and unconventional features and release premature shellfish species to ensure the continuity of their kind. The harvesting process is governed by a temporal flow, with certain months becoming sacred hiatuses and lunar phases as celestial orchestrators. The dance aligns with the ebb and flow of the tide, with *ugsad* (full moon) and *hunas* (low tide) ushering in preferred daylight hours for the gleaning of marine treasures. The *almanaque*, a local calendar chronicling the moon's phases and celestial events, serves as a revered guide, ensuring gleaning fishing folks' endeavors harmonize with the natural cadence of the ecosystem. This rhythmic pulse of the gleaning fishing community fosters a profound respect for the natural habitat and its mysteries, woven into their daily lives and echoed in their gleaning traditions.

Themes	Indigenous Knowledge	Scientific Knowledge	Relevant Science contents	Curriculum level
Fisheries	The fishing community engages in the collection of commercially significant local shell species, including *sihi* (nerite), *sigay* (tiger cowries), *sikad-sikad* (conch), *baka-baka* (*Lambis lambis*), *tirik* (*T. gratilla*), and *sobra-sobra* (*Aulica* sp.).	Nueva Valencia, Guimaras Island, boasts approximately 18 distinct local shell species (Municipality of Nueva Valencia, Province of Guimaras Archive). These species interact with each other in a dynamic ecological pattern within their own environment.	Biology: Taxonomic classification of invertebrates, specifically within Phylum Mollusca, encompassing classes Bivalvia and Gastropoda; exploration of biodiversity and species richness; food chain; energy transfer	Higher education, senior high school
Religion	Fishermen strategically avoid certain areas, deeming them as *mari-it* (enchanted) and believed to be protected by unseen beings. There is a prevailing belief that trespassing into these areas may incur a spell, motivating the community to leave these zones untouched and undisturbed.	Protected areas provide undisturbed habitats for juvenile marine species, allowing them to grow and explore the ecosystem. Several scientific studies support the assertion that protected areas provide undisturbed habitats for juvenile marine species. For instance, a study conducted by Jones et al. (2018) in marine reserves demonstrated enhanced growth rates and survival rates for juvenile fish compared to non-protected areas. Similarly, research by Halpern et al. (2019) highlighted the positive impact of marine protected areas on the diversity and abundance of juvenile marine species, indicating the significance of these zones for their development. These examples underscore the empirical basis for the statement, substantiating the importance of protected areas in fostering the growth and	Biology: Exploration of Ecosystem Dynamics and Interactions	Senior high school, upper secondary

		exploration of juvenile marine species.		
Health and Medicine	Fishermen refrain from collecting shells exhibiting vivid colors and unconventional appearances, such as crabs with algae-covered hairs on their carapace. Additionally, certain species of conch are deliberately avoided for consumption.	Cryptic coloration observed in certain animals, including crabs, sea snails, or conch, may indicate the presence of venom. Within the approximately 500 species of cone snails, each venom comprises 50 to 200 distinct biologically active peptides (Layer & McIntosh, 2006). Additionally, crabs with algae growth on their carapace often signal a potentially unpleasant taste.	Chemistry: Exploration of conotoxins, neurotoxins, proteolytic enzymes, protease inhibitors, and allergens.	Higher education
Conservation Biology	Fishermen selectively harvest fully matured shellfish, releasing small or juvenile animals back into the marine ecosystem to allow for growth. Species carrying eggs are also returned to ensure reproductive sustainability. Additionally, they refrain from collecting species lacking commercial value or those unsuitable for culinary purposes. Furthermore, shellfish collection is avoided during certain months, aligning with responsible harvesting practices.	Scientific studies, such as those conducted by Green et al. (2019) and Smith et al. (2020), affirm that leaving small and juvenile shellfish species uncollected fosters their continuous growth and reproduction. This practice contributes to the potential increase in shellfish populations in the future. Moreover, by refraining from collecting juvenile species and those with eggs, as exemplified in the research of Anderson et al. (2018), the sustainability of shellfish populations is effectively ensured. Such responsible resource use aligns with the concept of intergenerational equity, ensuring that present needs are met without compromising the ability of future generations to meet their own needs.	Environmental Sustainability: Exploring Ecological Dynamics	Higher education, senior high school
Earth Science	Fishermen rely on lunar phases as a key determinant for optimal shellfish collection times. The preferred collection periods coincide with daytime, *ugsad* (full moon), and *hunas* (low tide). Additionally, they consult a local calendar, known as *almanaque*, which delineates the moon's phases and lists astronomical events throughout the year.	The moon significantly influences Earth's tides. During the alignment of the Sun, Moon, and Earth, the solar tide combines with the lunar tide, resulting in an additional low tide. This phenomenon occurs due to the gravitational interaction between the Moon and Earth, causing the tides to rise and fall (Marine Environment Curriculum Study, 1974). The relationship between lunar phases and tidal patterns corroborates the understanding of the gravitational forces at play in shaping Earth's tides.	Physics: Exploring the Influence of Celestial Bodies on Tides, Gravitational Forces, Tidal Patterns, and Planetary Motion.	Senior high school, junior high school, upper elementary

3.1 Development of Science Lesson Exemplar

Gleaning fisheries is the traditional and commercial collection of marine species such as mollusks and echinoderms carried out usually, but not restricted to, intertidal zones and seagrass meadows when the low tide is at its maximum, and the weather is favorable to the shell collectors. Teachers may identify lessons congruent to gleaning fisheries, such as marine biodiversity, food chain, and energy transfer across trophic levels. The lesson plan exemplar developed in this study is contextualized to the needs of the learners who live in the coastal community, and the activities involved materials that are readily available and familiar to the learners. Thus, their science lesson is connected to the realities in their community. The exemplary lesson plan prototype followed the 7 Es Learning Cycle format (Figure 1) recommended by the Department of Education (DepEd) and the instructional design model suggested by the National Science Teachers Association (NSTA). It has seven (7) phases: Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate, collectively forming a strategic and dynamic sequence that optimizes the teaching and learning process.

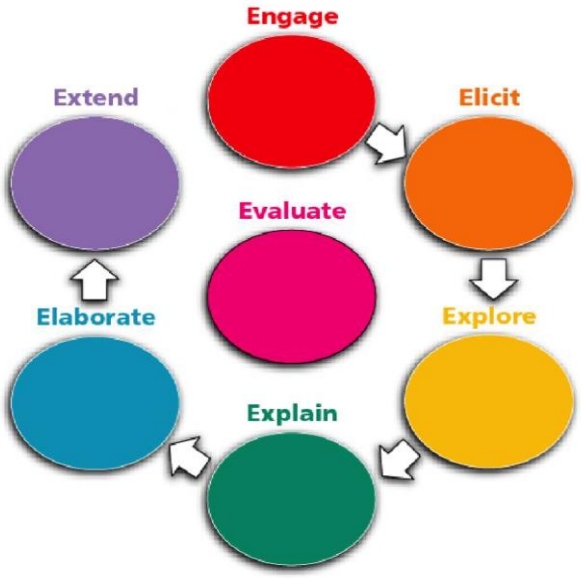


Figure 1. *The 7 Es Learning Cycle Model*

Table 2 presents the 7 Es lesson plan format contextualized to gleaning fisheries. The lesson plan starts with an elicitation phase in this format, activating prior knowledge and curiosity. It then moves to the engagement phase, involving interactive activities and multimedia resources. The exploration phase encourages hands-on learning and deeper understanding. The explain phase introduces formal instruction, demystifying complex concepts. The elaborate phase encourages students to apply knowledge in more complex ways. The extended phase challenges students to apply new knowledge in diverse contexts. The final phase evaluates and assesses students' mastery of lesson objectives, ensuring continuous improvement and informed future instructional decisions.

The prototype lesson plan (Figure 2) underwent a pilot testing phase involving 60 participants categorized as teachers and students. The pilot testing occurred within a school situated in a coastal community actively engaged in gleaning fisheries. The results in Table 3 revealed that the exemplary, contextualized lesson plan got an overall acceptance rating of 2.99 (M) with a standard deviation of 0.486 among students (n=30). Furthermore, the evaluation from teachers (n=30) indicated a notably higher level of acceptance, with a mean rating of 3.95 (M) and a standard deviation of 0.486.

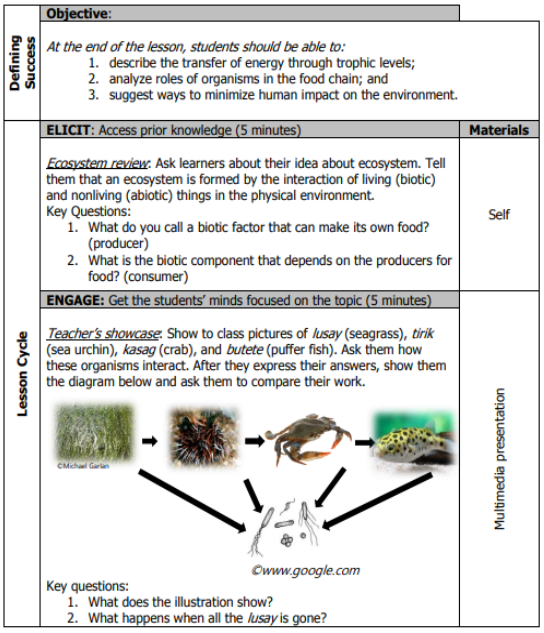
Table 2. *The Learning Cycle Format and Teaching-Learning Activities*

Learning Cycle	Activities
Elicit	The teacher initiated a process of understanding the students' existing knowledge by engaging them in a discussion about their perceptions and ideas regarding ecosystems. This involved posing questions to the learners, prompting them to articulate their understanding of the concept. One specific context explored during this knowledge exploration was the "*hunasan*" or intertidal zone, recognized as an ecosystem. Within this dynamic environment, the practice of gleaning fisheries, undertaken by both fishing community members and their children, was identified as a significant component. The intertidal zone, or "*hunasan*," emerged as an illustrative example of an ecosystem where the intricate relationship between the environment and the activities of fishing communities unfolded. This approach to teaching not only acknowledged the relevance of students' prior knowledge but also seamlessly connected theoretical concepts, like ecosystems, to real-world practices, fostering a more holistic and meaningful understanding among the learners.
Engage	The teacher directed the attention of the learners with a deliberate focus on their cognitive engagement, employing visual aids to enhance the educational experience. In this instance, the teacher presented illustrative materials showcasing a diverse array of species found in the intertidal zone. These visuals encompassed various organisms, including seagrass, native echinoderms, crustaceans, and mollusks, creating a vivid and comprehensive representation of the biodiversity thriving within the intertidal environment. By strategically using illustrations, the teacher aimed to deepen the students' understanding of the ecological intricacies of the intertidal zone, providing a visual context for the theoretical concepts discussed. This visual approach not only captured the learners' interest but also facilitated a more immersive and interactive learning experience, fostering a connection between theoretical knowledge and the tangible, diverse life forms inhabiting the intertidal ecosystem.
Explore	The teacher sought to establish a shared and experiential foundation for the learners by introducing a participatory activity known as "*Pasa Lukaba*" (Pass-the-Shell). This interactive game was carefully designed to create a common experience among the students, fostering a sense of unity and engagement within the classroom. The teacher methodically presented the mechanics of the game, explaining the rules and dynamics to ensure a clear understanding among the learners. The game, "*Pasa Lukaba*," served as an immersive and collaborative learning activity, providing a hands-on experience that transcended traditional teaching methods. By actively involving the students in this shared activity, the teacher aimed to not only enhance their understanding of the subject matter but also promote a sense of camaraderie and collective participation in the learning process.
Explain	The teacher proceeded to delve into the conceptual underpinnings of the introduced game, elucidating the underlying principles that connected it to a fundamental ecological concept. The game, "*Pasa Lukaba*," was strategically designed to symbolize the intricate dynamics of energy transfer within a food chain. In this context, the shells themselves served as symbolic representations of energy, embodying the flow of vital resources through various organisms in an ecosystem. Through this illustrative game, the teacher aimed to elucidate the interconnected relationships among different species and their dependence on one another for sustenance. The passing of shells from one participant to another mirrored the sequential transfer of energy within a food chain, emphasizing the vital role each organism plays in maintaining the overall balance of the ecosystem. This hands-on approach not only made the concept more tangible but also provided a memorable and engaging learning experience for the students, reinforcing their understanding of the intricate processes governing energy flow in ecological systems.
Elaborate	Following the theoretical understanding gained from the lesson, the learners actively applied their newly acquired knowledge by engaging in a practical exercise. Tasked with constructing their own food chain, the students drew upon the concept of energy transfer within ecosystems, particularly focusing on the species commonly found in the intertidal zone where they actively participate in *pagpanginhas,* or intertidal gleaning. In this hands-on activity, each student carefully selected and arranged the various species, including seagrass, native echinoderms, crustaceans, and mollusks, to form a cohesive and interconnected food chain. By doing so, the learners not only demonstrated their comprehension of the theoretical concepts but also showcased their ability to apply this knowledge in a context directly relevant to their local environment and cultural practices. This practical exercise not only reinforced the concept of energy flow within ecosystems but also empowered the students to actively engage with and contribute to the ecological understanding of the intertidal zone they regularly interact with during *pagpanginhas.*
Evaluate	The teacher employed an evaluative approach to gauge the depth of the learners' understanding by administering a straightforward multiple-choice test. This assessment aimed to measure the comprehension of the recently covered material, providing the teacher with valuable insights into the students' grasp of the key concepts related to ecosystems, intertidal zones, and energy transfer through food chains. The multiple-choice format offered a structured means of testing knowledge, requiring

learners to select the most appropriate response from a set of provided options. This method allowed the teacher to efficiently assess the students' recall of factual information, their ability to apply concepts, and their overall assimilation of the subject matter covered during the lesson. The assessment not only served as a tool for measuring individual progress but also informed the teacher's instructional decisions, enabling them to tailor future lessons to address specific areas of difficulty or reinforce particular concepts.

Extend

The learners' grasp of the conceptual framework was further enriched as they applied the acquired knowledge to a novel context. This extension of the concept beyond its initial presentation allowed students to explore its versatility and relevance in diverse situations. By introducing the concept into a new context, the teacher aimed to reinforce the understanding of its fundamental principles and demonstrate its applicability in various real-world scenarios. This approach not only encouraged a more profound comprehension of the concept but also fostered critical thinking and the ability to transfer knowledge to different situations. Engaging with the concept in a fresh context prompted learners to consider its broader implications, solidifying their grasp of its nuances and encouraging a more holistic understanding. This method of experiential learning enhanced the students' ability to adapt and apply the acquired knowledge, contributing to a more comprehensive and enduring comprehension of the conceptual framework.



Defining Success

Objective:

At the end of the lesson, students should be able to:

1. describe the transfer of energy through trophic levels;
2. analyze roles of organisms in the food chain; and
3. suggest ways to minimize human impact on the environment.

Lesson Cycle

ELICIT: Access prior knowledge (5 minutes) — **Materials**

Ecosystem review: Ask learners about their idea about ecosystem. Tell them that an ecosystem is formed by the interaction of living (biotic) and nonliving (abiotic) things in the physical environment. — Self

Key Questions:

1. What do you call a biotic factor that can make its own food? (producer)
2. What is the biotic component that depends on the producers for food? (consumer)

ENGAGE: Get the students' minds focused on the topic (5 minutes) — Multimedia presentation

Teacher's showcase: Show to class pictures of *lusay* (seagrass), *tirik* (sea urchin), *kasag* (crab), and *butete* (puffer fish). Ask them how these organisms interact. After they express their answers, show them the diagram below and ask them to compare their work.

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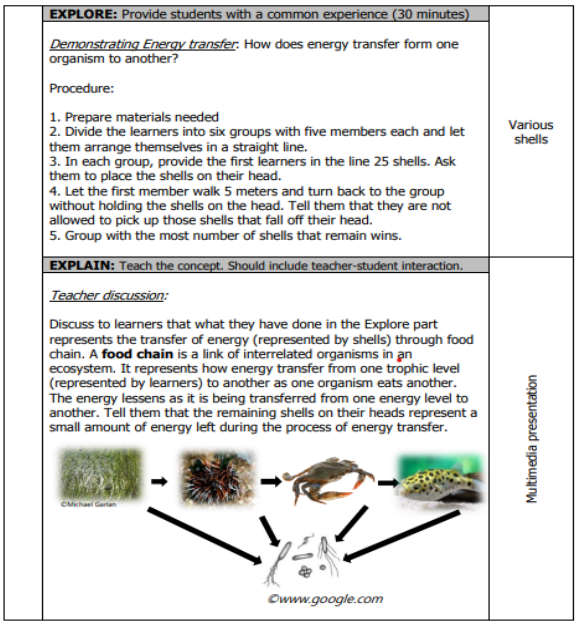
Key questions:

1. What does the illustration show?
2. What happens when all the *lusay* is gone?



EXPLORE: Provide students with a common experience (30 minutes) — Various shells

Demonstrating Energy transfer: How does energy transfer form one organism to another?

Procedure:

1. Prepare materials needed
2. Divide the learners into six groups with five members each and let them arrange themselves in a straight line.
3. In each group, provide the first learners in the line 25 shells. Ask them to place the shells on their head.
4. Let the first member walk 5 meters and turn back to the group without holding the shells on the head. Tell them that they are not allowed to pick up those shells that fall off their head.
5. Group with the most number of shells that remain wins.

EXPLAIN: Teach the concept. Should include teacher-student interaction. — Multimedia presentation

Teacher discussion:

Discuss to learners that what they have done in the Explore part represents the transfer of energy (represented by shells) through food chain. A **food chain** is a link of interrelated organisms in an ecosystem. It represents how energy transfer from one trophic level (represented by learners) to another as one organism eats another. The energy lessens as it is being transferred from one energy level to another. Tell them that the remaining shells on their heads represent a small amount of energy left during the process of energy transfer.

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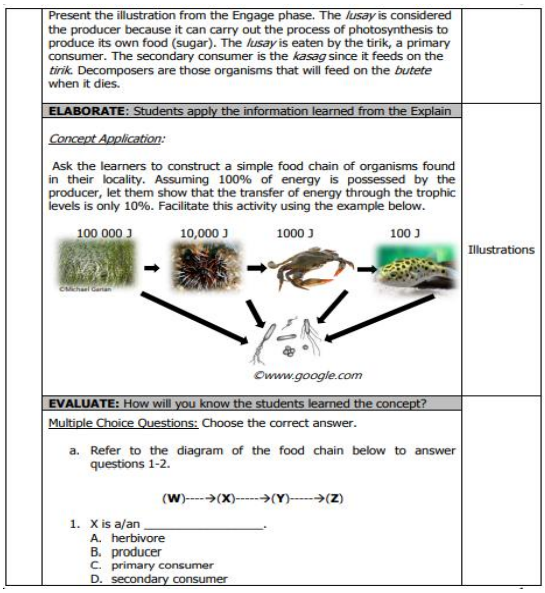

Present the illustration from the Engage phase. The *lusay* is considered the producer because it can carry out the process of photosynthesis to produce its own food (sugar). The *lusay* is eaten by the tirik, a primary consumer. The secondary consumer is the *kasag* since it feeds on the *tirik*. Decomposers are those organisms that will feed on the *butete* when it dies.

ELABORATE: Students apply the information learned from the Explain — Illustrations

Concept Application:

Ask the learners to construct a simple food chain of organisms found in their locality. Assuming 100% of energy is possessed by the producer, let them show that the transfer of energy through the trophic levels is only 10%. Facilitate this activity using the example below.

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EVALUATE: How will you know the students learned the concept?

Multiple Choice Questions: Choose the correct answer.

a. Refer to the diagram of the food chain below to answer questions 1-2.

(**W**)----->(**X**)----->(**Y**)----->(**Z**)

1. X is a/an _____.
   A. herbivore
   B. producer
   C. primary consumer
   D. secondary consumer
2. Which of the following correctly describes Y?
   A. It is a primary consumer
   B. It is a secondary consumer
   C. It is a tertiary consumer
   D. It is a decomposer
3. If *lusay* produces 1,000 joule of energy, how much energy will the primary consumer receive?
   A. 10 joule C. 100 joule
   B. 100 joule D. 0.1 joule
4. What is most likely to happen when all producers are removed from the food chain?
   A. All consumers will continue to survive.
   B. All the primary consumers will decline.
   C. The secondary consumers will increase in population.
   D. There will be an effect on the food chain.
5. Which organism is not considered as producer?
   A. *lusay* (seagrass)
   B. *bakhaw* (mangrove)
   C. *talisay* (*Terminalia sp*)
   D. *tilapia (O. niloticus)*

EXTEND: Deepen conceptual understanding through use in new context

Assignment: Ask the learners to construct a food chain using any of the available organisms in their place using a 1/8 illustration board or long bond paper. Tell them to present their output in class next meeting.

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Department of Education

Figure 2. *Sample Contextualized Lesson Plan Exemplar*

Table 3. *Students' and Teachers' Evaluation of Context-based Lesson Plan Exemplar*

	n	Mean	SD	Interpretation
Students	30	2.99	0.486	Acceptable
Teachers	30	3.95	0.486	Very acceptable

Note: 1.00-1.50, Not Acceptable; 2.51-3.50, Acceptable; 1.51-2.50, Merely Acceptable; 3.51-4.50, Very Acceptable

In culturally responsive pedagogy, akin to culturally relevant teaching, the approach capitalizes on the cultural knowledge, experiences, and performance styles intrinsic to ethnically diverse students. This pedagogical methodology aims to augment the quality of learning experiences by integrating and leveraging the diverse cultural attributes of the student population. It aims to improve academic success while affirming students' backgrounds and identities and connecting to individual students' home lives and experiences (Mensah, 2021 in NSTA). Culturally relevant pedagogy serves as a valuable tool for empowering students to glean knowledge and foster habits within the context of their own cultural background and comprehend the broader world beyond the confines of the school environment (Handa, 2008). This approach employs a comprehensive reliance on everyday experiences to perceive the world. In doing so, a teacher demonstrates respect for students and wholeheartedly embraces their customs, traditions, and individual home worlds (Hammond, 2001; Moll, 1992). Aikenhead (1996) emphasizes the importance of incorporating indigenous knowledge, local practices, and cultural values into science instruction to make it more accessible and engaging while fostering a deeper understanding of scientific concepts within their cultural heritage.

3.2 Development of Culturally Relevant Curriculum Framework

The framework presented in Figure 3 has been developed to serve as a guide in developing a culturally relevant lesson plan deeply rooted in the principles of indigenous science associated with gleaning fisheries. This visual representation shows the interconnected elements essential for creating an educational learning resource that aligns seamlessly with this small-scale fishing industry's cultural context and traditional knowledge systems.

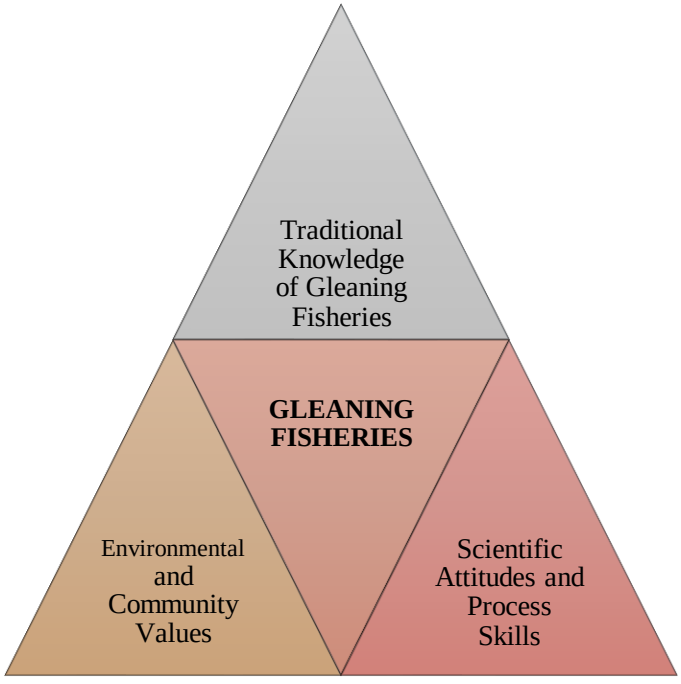

Figure 3. *Indigenous Science Framework Developed in this Study*

At the core of this concept map is the inclusive theme of indigenous science found in the gleaning fisheries, symbolizing the focal point around which scientific knowledge revolves. Branching out from this central theme are vital concepts representing diverse facets crucial to the cultural relevance of the science contents. These nodes

include local wisdom, traditional practices, and community values, embodying the unique cultural tapestry that shapes the indigenous knowledge landscape. It also represents a framework for pedagogical implication, acknowledging the need for a teaching approach that resonates with the community's socio-cultural context. Integration with the existing curriculum can be implied, highlighting the importance of aligning the teaching strategies with established educational frameworks while infusing it with the richness of indigenous perspectives and environmental attitudes.

Moreover, the framework emphasizes engagement strategies that promote scientific attitude and skills, fostering a dynamic learning process. Practical applications of indigenous science are also delineated, showcasing how theoretical concepts seamlessly translate into real-world scenarios relevant to the community's daily life. This framework serves as a visual model, illustrating the intricate interplay of elements essential for developing a culturally relevant curriculum grounded in indigenous science. It encapsulates a holistic approach that not only respects and integrates local knowledge but also endeavors to create an educational experience that resonates authentically with the community's lived realities and cultural heritage.

3.3 Traditional Knowledge of Gleaning Fisheries

Within the community, a vibrant tapestry of traditional knowledge intricately weaves together cultural practices, with a particular focus on methods such as gleaning fisheries, ethnobiology, and folk astronomy. As Simons et al. (2016) articulated, traditional knowledge encapsulates a universal understanding among indigenous people, encompassing various facets of life such as history, habits, religion, morality, politics, art, and the intergenerational transmission of wisdom. In the specific context of gleaning fisheries, the traditional knowledge held by the community serves as a cornerstone for sustaining their way of life. The fishing folks of the identified coastal community exhibit a profound mastery of their gleaning fisheries tradition, drawing upon celestial objects to intricately gauge tidal patterns. Their expertise extends beyond simple collection; it encompasses a subtle understanding of species identification, hunting techniques, and the art of imparting this knowledge to subsequent generations.

Moreover, the community shares a rich repository of superstitious beliefs, notably those surrounding "*tag-lugar*," unseen beings believed to inhabit towering trees and enchanting places (*mari-it*). Rather than mere folklore, these beliefs play a vital role in environmental conservation, acting as a deterrent against exploitative practices within the area. This intricate web of traditional knowledge serves as a sustaining force, ensuring the preservation of the environment and preventing undue exploitation. The transmission of this multiperspective knowledge is a testament to the community's commitment to preserving the traditional gleaning fishery. These teachings form an invaluable legacy passed down through generations, fostering a deep connection between the past, present, and future. In essence, the community's embrace and demonstration of traditional knowledge contribute to the sustenance of their livelihoods and embody a profound understanding of the interconnectedness between cultural practices, environmental stewardship, and the preservation of their unique ways of life.

3.4 Environmental and Community Values

Indigenous science, deeply rooted in environmental and community values, reflects a deep connection between the community and the coastal ecosystem, which is their livelihood. The gleaning fishing folk community members, acting as stewards of natural resources, are responsible for safeguarding and nurturing this vital ecosystem. Drawing inspiration from the insights of Straton and Pearson (2008), ecosystem services emerge as a key concept, denoting the natural commodities and provisions critical for sustaining the welfare of those who depend on them. Ecosystem services, including water, climate regulation, and disease control, are intricately linked to the environment's essential components, including soil, water, air, plants, and animals. As highlighted by Barry Commoner's seminal concept from 1971, "Everything is connected to everything else," the coastal community perceives and respects the profound interconnectedness of its ecosystem. This interconnectedness emphasizes that the community's well-being is intricately tied to the health and vitality of their natural surroundings.

In their role as stewards, the gleaning fishing folks of the coastal community prioritize the sustainable management of resources, demonstrating a conscientious approach to prevent exploitation. Recognizing the repercussions of resource depletion on ecosystem services, they actively engage in practices that ensure the

regeneration and preservation of these valuable components. This deliberate effort aligns with their commitment to not only meet present needs but also to responsibly re-establish these resources for the benefit of future generations. In essence, the gleaning culture practiced by the fishing folk community embodies a holistic understanding of the environment, emphasizing the mutualistic relationship between human communities and the ecosystems where they live. This moral nature of responsible stewardship underscores a commitment to maintaining the delicate balance between resource utilization and conservation, ensuring the sustained well-being of the community and its coastal ecosystem.

3.5 Nature Dynamics and Science Process Skills

Indigenous science, profoundly ingrained in the cultural fabric of communities, represents a repository of skills and insights honed and transmitted from generation to generation. These scientific skills encompass a range of observational, analytical, and problem-solving abilities, allowing communities to comprehend and navigate their physical environment effectively. These scientific skills manifest prominently within the coastal community as residents leverage their profound expertise in observing intricate tide patterns, deciphering winds, and gauging the total growth of various marine species.

The science of observation, handed down through familial and communal traditions, allows community members to discern subtle nuances in their ecosystem, often imperceptible to untrained eyes. Additionally, the ability to measure and interpret these observations enhances their scientific understanding, aligning indigenous knowledge with empirical data. This harmonization of traditional wisdom with scientific insights empowers the coastal community to develop context-specific adaptations and mitigations that foster the resilience of their socioecological systems. The coastal community's observation and measurement practices are crucial in addressing climate change challenges. Indigenous knowledge helps evaluate climate change impacts and aligns with climate models. By integrating indigenous and contemporary climate science, communities can contribute to informed decision-making and adaptive strategies. This collaborative approach strengthens resilience and enriches broader scientific understanding by incorporating localized perspectives and insights. In summary, utilizing skills passed down through generations in the coastal community exemplifies the dynamic synergy between indigenous science and empirical data. This amalgamation enhances the community's ability to navigate and sustain their environment and positions them as valuable contributors to the broader discourse on climate change and social-ecological resilience.

Figure 4. *Some Species of Mollusk Gleaned By Fishing Folks*

Within the gleaning fisheries community in the Philippines, the indigenous science practiced by fishing folks integrates traditional knowledge about marine species (Fig. 4), celestial observations, and superstitious beliefs to establish a harmonious relationship with nature. This holistic approach is grounded in respecting nature and maintaining a delicate balance in their lives. The community's gleaning fisheries practices offer a compelling example where the avoidance of collecting undersized and juvenile species aligns with their foresighted use of natural resources, considering the impacts on future generations.

The present study revealed that the fishing folks (Fig. 5) engaged in gleaning fisheries have learned the correlation between celestial bodies and natural phenomena, validating their use of celestial observations to understand and

navigate nature. Additionally, it highlights the role of superstitious knowledge in preserving coastal environments, shedding light on the intricate interplay between cultural beliefs and environmental conservation.

Figure 5. *Typical Day for Gleaning by Fisher Folks in the Intertidal Zone*

Integrating indigenous science into science education exemplifies interdisciplinary, encompassing chemistry, biology, and physics alongside cultural, ecological, and economic dimensions. This interdisciplinary approach is evident in exploring environmental issues from diverse perspectives, fostering a holistic understanding. The fishing folk's philosophy, emphasizing the preservation of nature and the pursuit of a balanced and prosperous existence, offers valuable insights for accommodating environmental ethics in the science curriculum. Students engaged in cultural practices may bring different funds of knowledge accumulated through their lived experiences into the classroom, and these experiences can be utilized to teach meaningful science. Students who are children of gleaning fishing folks and gleaners themselves bring a wealth of knowledge to the classroom, shaped by their personal encounters, cultural backgrounds, and individual perspectives. By recognizing this wealth, science educators can impart meaningful scientific education. Each student's journey outside the classroom contributes to a distinct tapestry of knowledge, ranging from cultural practices like gleaning fisheries to personal observations. By integrating these diverse funds of knowledge, educators can bridge the gap between the tangible realities of students' lives and abstract scientific concepts. This holistic approach makes science education more relevant and transforms the learning process into a dynamic, interactive exploration of the world. Students become co-creators of their scientific learning experience, fostering a more inclusive and engaging educational environment. Educators can unlock a wealth of perspectives by tapping into students' diverse knowledge, encouraging critical thinking and a deeper understanding of scientific principles. In doing so, the classroom becomes a dynamic space where the fusion of personal experiences and scientific exploration cultivates a profound and lasting appreciation for the wonders of the natural world. Aikenhead (1996) emphasized the importance of incorporating students' cultural backgrounds, beliefs, and everyday experiences into science education and argued that science learning should not be detached from students' cultural contexts but should instead be integrated with their lived experiences.

In culturally relevant teaching, Aikenhead (1996) underscores the significance of recognizing and incorporating indigenous knowledge, local practices, and cultural values into science instruction. He contends that such an approach not only makes science more accessible and engaging for students but also fosters an appreciation and understanding of scientific concepts within the framework of their cultural heritage. His work advocates a shift from a one-size-fits-all approach to science education. It encourages educators to tailor their teaching methods to resonate with the diverse cultural backgrounds of their students. By doing so, he believes that educators can enhance the relevance of science education, improve student engagement, and promote a more inclusive and equitable learning environment.

4.0 Conclusion

The research emphasizes the significance of indigenous science in Philippine gleaning fisheries as context for science teaching. Integrating indigenous science into classroom instruction can create a transformative learning experience, bridging the gap between formal education and learners' cultural contexts. This approach allows educators to understand learners' perspectives, thinking processes, and unique cultural insights, making the

learning journey more meaningful and effective. It also contributes to preserving and celebrating indigenous knowledge and practices, making the teaching-learning process more meaningful, relevant, and inclusive.

5.0 Contributions of Authors

The author confirms the contribution to the paper as follows: *Corresponding author*: study conception, design, data collection, analysis, interpretation or results, draft of the manuscript, and presentation.

6.0 Funding

National Consortium in Graduate Science and Mathematics Education (NCGSME), Department of Science and Technology-Science Education Institute (DOST-SEI).

7.0 Conflict of Interests

The author declares no conflict of interest.

8.0 Acknowledgment

The author wishes to express his gratitude to the DOST-Science Education Institute.

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