Indigenous Science as Everyday Science: A Proposed Curriculum Framework for Developing Science Literacy Among Young Children

Greg Tabios Pawilen

College of Human Ecology, University of the Philippines Los Banos, Laguna, Philippines

Abstract: *The development of science literacy and learning science have become essential components of the basic education agenda in the Philippines. Consequently, findings from the Programme for International Student Assessment (PISA) serves as the benchmark for improving the science curriculum. This study aims to explore indigenous science as a foundation for everyday science, and to design a culture-responsive framework for developing science literacy among young Filipino children. This is a qualitative study that uses the wealth of qualitative data to obtain the views and experiences of community elders, parents, and teachers. The data were analyzed qualitatively to develop an understanding of indigenous science knowledge and practices and qualifying it as everyday science, which is an essential theory in designing a framework for developing science literacy for young children. The study concludes that indigenous science intertwined with the daily life experiences of the people offers a solid basis for learning science. It situates the learning of science and doing science in a cultural context, thereby making science as a personal, social, and intellectual activity interwoven in the everyday life of the people. The proposed culture-responsive framework for developing science literacy among young children is essential for improving pedagogy, developing science literacy and to connect science at with peoples' activities at home and community.*

Keywords: *indigenous science, curriculum, science literacy, Filipino*

1 Introduction

Science is essential in everyday life, and the study of science has become imperative in the school curriculum. However, indigenous science, though it is encouraged, has always been neglected as part of the school science curriculum. Notably, the author is the only one doing research on indigenous science for young children in the Philippines. This paper contends that indigenous science forms the everyday science as experienced by the people and part people's culture are essential foundation for designing and developing a science curriculum that is relevant and responsive to the people. For instance, the PISA expects that learners in science could use science concepts and skills to understand several issues and problems affecting the lives of people. Consequently, learning science must connect science ideas with the everyday life context and experiences of the learners.

Science as a subject in school is the best venue for providing answers to questions, offering solutions to problems, and discovering everything about the world that includes human beings. For a thousand years, human beings have been asking questions about what they have observed and experienced around them. The answers they have come up with have changed a lot with the development of new knowledge and with the support of data. Human beings recognize the importance of data and careful observation in providing answers and explanations to questions and inquiries. From simple curiosity and observation to experimentation, science evolved into a dynamic intellectual, social, and personal activity. What has not changed is the curiosity, creativity, imagination, innovative behavior, and attitudes and values of those doing science.

People have come to recognize science as one of the vital elements in building a progressive society. Therefore, developing a citizenry with a high level of science literacy has become imperative in every society. A science literate individual is expected to creatively participate in the cultural, economic, and political development of society (Faustino, Alata, Pawilen, Castro, et.al. 2024; Pawilen,2023). With the goal of developing science literacy for all people, introducing learning and doing science to young children is essential (Chaille and Britain, 2002).

Science in everyday life is recognizing that science ideas, process skills, attitudes, and values exist and are practiced by all people in their everyday lives. This idea puts science in the context of everyday life activities, which is imperative for learning science and popularizing science ideas in a more creative way. Indigenous science as everyday science is a recognition of the essential contribution of culture to the development of science ideas and practices, and an appreciation of science as part of human culture. It is acknowledging the epistemology of indigenous science as scientific. This kind of place-based pedagogy intensifies the possibility for the learners to feel proprietorship over their education and diminishes the circumstances that produce their isolation or indifference (DepEd, 2023; Pawilen, 2021, 2017; Pawilen & Sumida, 2009, 2007; Ignas, 2004). It provides scientific knowledge in the learners' culture, circumstances, necessities, and history in an innovative way, and it develops scientific literacy in all young children, regardless of culture, conviction, or leaning (Cajete, 2004).

Learning indigenous science as everyday science is based on the dogma and framework of a learner-centered education that emphasizes the knowledge (including indigenous knowledge), skills, personal and collective values, and viewpoints of the learners (Bransford, et al., 2000). It aims to make science culturally responsive, relevant, appropriate, and compatible where the local language of the learners is used as the medium of instruction and the cultural practices of the learners are appreciated. Learning science as a cultural activity includes cultural scripts, or the cultural orientations, worldviews, and epistemology about the world that is commonly communicated among the learners.

Ideally, learning indigenous science as everyday science is a form of empowering education that reflects the learners' culture, social situation, needs, and history. Learning indigenous science curriculum as everyday science is also an example of Dewey's (2001) democratic education that enables the learners to transform knowledge from culture and personal experiences. This type of education brought life to learning pathways, culture, worldview, and pedagogy that are liberating and genuinely indigenous. Learning indigenous science as everyday science equips young children with scientific knowledge and skills that are essential in daily life. It connects learners from local and indigenous communities with their scientific knowledge and the socio-cultural context. It keeps to the conception of science being inseparable from society (Nowotny, et al., 2001). It recognizes science as part of human history (social and personal) that helped produce decisive transformations in science (Kuhn, 1962).

The everyday experience of young children is the foundation for learning science. Science in kindergarten includes a process of scientific inquiry – theorizing, hands-on and open-ended activities, and simple experiments that involve children at a wide range of developmental levels, and individual strengths and needs. Through science, young children acquire vital ideas and data that are associated to their daily life experience (Ozer and Dogan, 2023; Meador, 2005; Worth and Grollman 2003; Carale and Campo, 2003; Conezio & French, 2002). Through science, young children also develop essential skills such as process skills, creativity, innovative attitude, critical thinking, and life skills that are required in managing daily life activities (Chaille and Britain, 2002). Science begins with curiosity and a strong desire to discover and explore the environment (Evans, 2005; Harlan and Rivkin, 2004; de Boo, 2000), which is imperative in the development and production of knowledge (Freire, 1998). This establishes the foundation for all future learning, especially in the development of science literacy. (Evans, 2005; Harlan and Rivkin, 2004).

2 Methodology

This is a qualitative study that involves interviews, focus group discussions (FGD), and participant observations in a local community located in a northern province of the Philippines. The data are gathered, analyzed, and reported qualitatively. It uses a narrative research strategy of inquiry developed by Clandinin and Connelly (2000) to study the lives of the people and identify the problems and issues that indigenous peoples experience every day. This strategy was also used to collect indigenous scientific knowledge and practices from the people, as well as to learn how they are passed down to the next generation. The community's key informants for this study were purposefully chosen from among educators, community officials, and community elders who are tribal officers. These people have wide contact with people in the community, and they have seen and experienced many social, cultural, and political developments in the community. They are also guardians of the indigenous knowledge and practices of the community.

Data were gathered using qualitative methods like interviews, FGD, and site visitations. First, a discussion to explain the purpose of the study and to develop awareness of community folks on the basics of kindergarten education and their possible role in curriculum development. After this activity, the community members are asked to participate in an FGD that will contribute to the study's objectives. The data were analyzed using the thematic method of analysis. The responses were organized into different themes that identify the science-related issues and problems experienced in the community and identify indigenous science knowledge and practices observed by the people. The ethical requirements of conducting research in indigenous communities were considered and complied with. Confidential information was excluded from the analysis to respect the privacy of the participants.

3 Results and discussion

The purpose of the study is to explore indigenous science as a foundation for everyday science,

and to design a culture-responsive framework for developing science literacy among young children.

3.1 What science-related issues and problems are experienced in the community?

If science is a social and personal intellectual activity, it should involve problem solving, providing possible answers, and explaining phenomena. Science should be closely linked to people's problems and daily life experiences. In the 2018 PISA Science Framework, the challenge is discussing science in the context of personal, family, community, national, and global issues, problems, and concerns. Another challenge is to provide science-based explanations for various phenomena that people observe and experience daily.

In this study, the science-related issues and problems can be classified into three categories: (1) environmental, (2) economic, and (3) health concerns.

Table 1 Environmental issues and problems

• Drying of rivers and streams
• Changing of climate
• Frequent experience of earthquakes
• Presence of sinkholes
• Pests destroying their crops
• Animal diseases
• Air and water pollution
• Waste management

These environmental concerns need scientific knowledge and explanation. The presence of these environmental issues and problems could build a strong foundation for learning earth science, geology, geography, life sciences, and physical sciences that is based on the context of environmental issues and problems experienced by people. It calls for learning science as environmental science. Similarly, people's experiences and observations in dealing with natural and man-made disasters will strengthen and complement discussions of science concepts in everyday life (Faustino, Alata, Pawilen, Castro, et.al, 2024)

Table 2 Economic issues and problems encountered by the community

• High electricity bills
• High price of gasoline and diesel fuels
• Increasing prices of food products
• Fare hikes
• Poor financial literacy
• Poor resource management

The economic issues and problems identified in Table 2 will require basic science knowledge of electricity, energy conservation, and alternative energy. These problems and issues necessitate scientific problem-solving and data-analysis skills. Again, these may help educators in selecting more relevant topics to be included in physical sciences, especially on the theme of matter, energy, and technology in the kindergarten and elementary science curriculum.

Table 3 Science-related Health Issues and Problems Experienced by the People

- Obesity
- Increasing number of cardiovascular cases
- Mosquito borne diseases
- Influenza
- Increasing cases of diabetes
- Food allergies
- Elderly diseases (gouts, rheumatism)
- Cough and colds during the rainy and cold months of December to January

Health is a major concern for every individual. The result in Table 3 reflects the basic health issues and diseases or illnesses experienced by the people in the community. These health issues and problems may call for discussing science concepts and ideas in the context of health issues and problems. Providing science-based explanations will significantly increase the level of awareness about the prevention and cure of these illnesses and diseases. It will lessen the fears and paranoia of people when they experience a pandemic or epidemic.

3.2 What indigenous science knowledge and practices are observed in the community?

The indigenous science knowledge can be classified into three categories: (1) environment (2) economic, and (3) health concerns.

Table 4 Indigenous science knowledge and practices related to the environment

- *Sar-sarita* (using local stories) highlights the protection and preservation of natural resources
- *Bignas* (local celebrations and rituals) calls for rainfall during planting season
- Observing animals' behavior to predict weather conditions and seasons
- Observing celestial bodies to predict weather conditions and possible environmental problems: *tikag* (too much sunlight), *lem-lem (rainy), nakuyem* (cloudy so it might rain), *na-bituen* (stary skies for good weather), *kabulanan* (full moon for good weather), and *Bandos* (comet that may signify drought so people should prepare)
- Indigenous method of classifying animals into families and groups based on use and other cultural properties
- *Taraken* for pets and farm animals, *atap* for forest animals, *lames* for fishes
- Selecting *bin-i* (good seeds) and *bunubon* (young crops) for planting
- Building *pin-ned* (local irrigation system) to water rice fields and other crops
- Classifying different types of soil based on observable properties: *kadagaan* (dry soil), *pila* (clay soil), *nabugaso* (fertile soil), *kabatuan* (rocky soil), and *kadaratan* (sandy soil)
- *Lampadan,* an indigenous system of planting local varieties of rice in the slopes of the mountain
- *Bangkag,* a system of planting crops in a dry land

Table 4 shows the indigenous science knowledge practiced by the community. These indigenous science practices are products of human ingenuity in trying to understand their environment and in their desire to provide an explanation for various natural phenomena. They are creative ways of preserving life on the planet, and they are products of human observation and interaction with nature. These are sciences in everyday life that people have learned, practiced, and experienced since the time of their ancestors ((Meador, 2005, Worth and Grollman 2003, Carale and Campo, 2003; Conezio & French, 2002).

The indigenous people also use stories and beliefs about anitos or spirits that guard a particular place (mountains, rivers, waterfalls, streams, and seas) to protect them from destruction because of human activities or believe that certain spirits reside in old trees to avoid them being cut down by people. While there is no scientific basis for this indigenous belief, it helps sustain the beauty of nature and protect the environment from human activities.

There are classifications where these indigenous sciences are parallel to certain areas of science like (1) taxonomy or understanding of plants, animals, soil, water, air, weather and climate, and other environmental phenomena; (2) science attitudes like honesty, curiosity, objectivity, openness, determination, attentiveness to details, being critical, and being trustworthy; (3) technology; (4) management of resources; (5) natural balance or the interrelatedness, interdependence and relationships of living and non-living things.; (5) evolution and genetics like origins, heredity, and changes; and (6) systems or the understanding and awareness of processes that happen to living and nonliving things.

The indigenous science knowledge and practices, as shown in Table 5, also helps the people in various economic activities in everyday life. The presence of indigenous mathematics (counting, measuring, estimating) also strengthens a lot of IK practices related to business, entrepreneurship, and trades. Indigenous science (ethno-chemistry, ethnobiology, ethno-physics) is useful for the economic survival of the indigenous people. They are used in preserving foods and cooking, they are used in exploring energy sources, and they are used in sustaining their main crops such as rice, corn, and vegetables. The Ilocanos in general are known to be kuripot or stingy people. This is because they want to teach to their children the value of simple living, spending only what you need, and saving resources for future use. The cultural values such as the ammoyo are also useful to sustain good relationships, trust, and cooperation among the people.

Table 5 Indigenous science knowledge and practices related to economic activities

- Using indigenous tools for farming and in everyday life
- Maximizing the use of alternative energy
- Indigenous way of preserving foods using *tagapulot* (locally produced unrefined sugar from sugarcane), special herbs, *asin* (local salt), and *suka* (local vinegar from sugarcane)
- *Muy-muyong* a system for backyard gardening and planting edible plants
- *Tantya* and indigenous method of mathematical estimation and data analysis
- *Sinnukat* a system of barter or exchange of goods
- *Punggos* an indigenous mathematical system for grouping goods (usually vegetables) to be sold
- *Rakem* an indigenous mathematical system for measuring grains and seeds
- *Ammoyo* a system for collaboration or helping each other in times of crisis
- *Panagurnong* and *panag-ekonomya* a system and cultural values of saving money and other resources for the future

Panag-ekonomya is useful in teaching young children and all people the value of saving resources and energy. Tantya is also helpful in teaching young children to analyze simple data. Tantya is not only about measuring or estimation. It also includes critical analysis, logical reflection, data-based decision, and futuristic thinking that are related to science attitudes.

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Table 6 Indigenous science knowledge and practices for health and medicine

- Using herbal medicines
- Producing health drinks and wines from tropical fruits
- *Pa-asok* or using the smoke from burning certain plants to drive mosquitoes
- *Su-ob* or steam inhalation (steam from special plants and other herbs)
- *Ilot* or body massage to restore healthy body
- Living harmoniously with other people in the community to sustain peace of mind and good health
- Putting an object (or food) to fire to kill germs
- Water therapy

As shown in Table 6, the people's indigenous science and practices also includes health and medical practices that helped the indigenous people to survive many tropical diseases and health problems.

Table 7 Indigenous science beliefs

- The land is a spring of life which is a treasured gift from God
- The earth is honored as "Mother Earth". It is the genesis of their identity
- Nature and human beings are reliant and mutually dependent with each other.
- Humans are keepers of all creatures
- Nature needs respect and proper care

Table 7 shows the indigenous beliefs of the people. These beliefs can foster desired values that are relevant to or consistent with different attitudes toward science. Johnston (2000) grouped these sets of attitudes into motivating, practical, reflective, and cooperating attitudes. These attitudes could evolve into positive values by bringing science to a personal level.

3.3 How do parents teach this indigenous science system to young children?

The study found out that teaching of indigenous knowledge to young children is a challenging task for parents and community elders especially due to lack of teaching resources. This was the same issue raised by Madlela (2024) in a study to incorporate indigenous knowledge system into the natural science curriculum . Table 8 shows the different ways in which parents and community elders teach indigenous science to the young generation, especially young children in their community. A study by Pawilen (2023) pointed out that most of these methods of teaching indigenous science involve oral tradition and a creative process that involves using music, oral literature, dances, and other arts to communicate ideas.

Songs and poems are always on the theme of love, solidarity, justice, heroism, ecological spirituality, protection of the environment, and appreciation of the natural beauty around us. Stories, poems, and riddles are narrations of heroism, the history of people and the community, and stories with moral values that will guide people in everyday life, especially in making

decisions. These works of music and literature function as springboards or schema for communicating scientific ideas. This confirms the previous study conducted by Pawilen (2021)

Table 8 Ways of teaching indigenous science to young children

- *Panag-sarsarita* – using local stories, fables, and legends
- *Kankanta* – using songs and music
- *Daniw* – using poems
- *Panag -burburtia* – riddles and oral puzzles to solve
- *Pammag-baga* – giving advice and values clarification technique
- *Panangidalan* – apprenticeship, modeling, and mentoring
- *Panag-sal-saludsod – using questions*
- Personal and actual experience and observation
- Memorization
- Critical dialogue and group discussion
- Using traditional dance and arts

Pammag-baga, panangidalan, panag-sal-saludsod, and critical dialogue are critical thinking processes that require deep reflection, evaluation, analysis, synthesis, and problem solving. The elders and parents would start the conversation with a critical question that required an opinion based on personal experience, observation, and available data. The conclusion is always strengthened by the indigenous knowledge, values, and beliefs of the people. Memorization is a natural learning process, so young children will not forget the indigenous knowledge, history, values, and beliefs that they learn. Seehawer (2018) pointed out that using the learners' communities as resources for teaching and learning, is a good pedagogical strategy in school.

It is also through these discussions, questions, and dialogues that parents discover the interests and talents of young children. The types of questions and the answers that young children give provide bases for understanding what they know, understand, and value. Teaching indigenous science as part of everyday science to young children also strengthens the idea that active learning, personal experiences, actual exploration, conducting observations, and other constructivist methods are useful in learning science among young children. It also affirms the important role of family, especially the parents, in nurturing the interests of young children towards learning and doing science.

These creative and critical processes are effective ways of communicating science ideas and science values to young children. It makes the learning of science more creative, inclusive, and personal. As a social and intellectual activity, science should reflect how people express their ideas and how they learn. Consequently, science should be closely linked with the culture of the people, and science should be part of the people's culture. Using these methods in science teaching and learning could help to develop stronger science literacy among young children in local communities. These cultural practices and traditions are concrete and imaginative depictions of how they observed natural phenomena and lived in harmony with nature. The songs, chants, dances, rituals, and stories encompass language metaphors of how people view the environment in relation to their daily lives (Pawilen & Sumida, 2009, 2007).

In the school, the teachers likewise observed that young children want to move, observe, and do things to experience the adventure of exploring the natural environment and the joy of finding out things to satisfy their curiosity. The teachers explained that there are also several opportunities available for children to see and explore the context of their daily life and culture in the present science curriculum, like: (1) using local children's literature like stories and poems as motivation for young children during science lessons, (2) identifying examples of traditional

tools used by people in the community, (3) inviting community elders as resource persons during class sessions, and (4) conducting fieldtrips to visit some places in the community.

3.4 What framework for developing science literacy can be developed and proposed for schools and families?

Based on the results of the study, the proposed framework for developing science literacy among young children, shown in Figure 1, includes 2 important elements: (1) curriculum content, and (2) pedagogy for learning science.

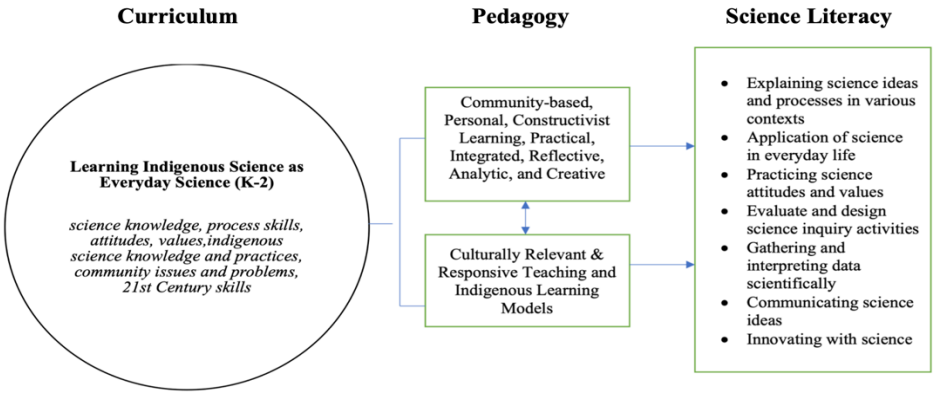

Figure 1 Proposed framework for developing science literacy among young children

The framework shows that learning science among young children should start as early as kindergarten. The curriculum from kindergarten to Grade 2 includes learning indigenous science as everyday science, starting with the study of origins and heredity, identification of local plants and animals, matter and energy around us (home and community), and earth science (with emphasis on observable heavenly bodies and physical geography). Learning indigenous science as everyday science requires a curriculum that is integrated. This means science will utilize themes that reflect human interests, issues, and problems, especially those that were mentioned in Tables 1 to 3 (environment, economic, and health). Integrated science will closely link science ideas, process skills, attitudes, and values to the daily life issues, challenges, problems, and concerns of the people. It will present science as a human intellectual and social activity.

The pedagogy for learning indigenous science includes culturally relevant teaching and indigenous learning models. Personal, active learning, practical, community-based, constructivist integrated, reflective, analytic, and creative pedagogical approaches are used in grades K-2. Through these pedagogical approaches, young children will develop a strong historical and cultural connection with science. They will recognize themselves and their communities as participants in the evolution of science as a discipline and the development of scientific ideas.

The goal of teaching indigenous science as everyday science is the development of science literacy, which involves the development of an individual who can (1) explain science ideas and processes in various contexts, (2) apply science in everyday life, (3) practice science attitudes and values, (4) evaluate and design science inquiry activities, (5) gather and interpret data scientifically, (6) communicate science ideas, and (7) develop innovation using science knowledge and skills. These qualities are desirable for a person living in a scientifically driven society.

4 Conclusion

Recognizing indigenous science as everyday science is an equitable recognition that science is part of the culture, identity, and history of the people. It recognizes the important contribution of various people and culture in the development of science knowledge, and it is a recognition that science is an integral part of everyday life. Indeed, science, people, and society are inseparable; they are complementary, interrelated and interdependent. Therefore, it could be considered that indigenous science is part of the natural philosophy that gave birth to the development of science as a discipline and field of study.

Indigenous science as everyday science will improve the development of science literacy of the people starting among young children. Indigenous science knowledge and practices will serve as the foundation for developing science concepts and process skills. It will also set the development of science attitudes and values that are useful in everyday life. Recognizing indigenous science as everyday science removes the alienation of indigenous people towards western science with the hope that in the future, the difference between western science and indigenous science will be removed.

Indigenous science as everyday science can ignite and sustain young children's curiosity and interest in learning and doing science. It will help them study science patterns in everyday life and explain phenomena scientifically. It will help them recognize the value of empirical data, observation, and experimentation. Likewise, indigenous science as everyday science will create a pedagogy that is culturally relevant and responsive to the needs and context of the people.

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