INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

Graces from the Sea: Strengthening Science Curriculum Through a Marine Museum

Fernan Peniero Tupas[1,2]*, Toshihiko Matsuura[3], Sunny Gabinete[4], Marigrace Astronomia[4], Rosario Noderama[4], Violeta V Guillergan[4], Alni Grace D Espinosa[5], Aries B Cabahit[6], Richelle Sanchez[6], Shella D Delgado[6]

1 Professor, Northern Iloilo State University, Iloilo, Philippines
2 Postdoctoral Fellow (Standard), Japan Society for the Promotion of Science at Hokkaido University of Education, Hakodate, Japan
3 Professor, Hokkaido University of Education, Hakodate, Japan
4 Associate Professor, Iloilo State University of Fisheries. Science and Technology, Iloilo, Philippines
5 Faculty, Northern Iloilo State University, Iloilo, Philippines
6 Faculty, University of Antique, Antique, Philippines

OPEN ACCESS

Received: 16-01-2023
Accepted: 05-05-2023
Published: 06-12-2023

Citation: Tupas FP, Matsuura T, Gabinete S, Astronomia M, Noderama R, Guillergan VV, Espinosa AGD, Cabahit AB, Sanchez R, Delgado SD (2023) Graces from the Sea: Strengthening Science Curriculum Through a Marine Museum. Indian Journal of Science and Technology 16(45): 4200-4210. https://doi.org/10.17485/IJST/v16i45.118

* **Corresponding author**.

ftupas@nisu.edu.ph

Funding: None

Competing Interests: None

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

Abstract

Objective: In many countries, the museum is always part of science education. The primary purpose of this study was to create a marine museum as instructional material in the science curriculum in Japan and the Philippines. **Methods**: This study used documentary and developmental research to create a marine museum as instructional materials in the science curriculum in Japan and the Philippines. Information Education and Communications (IEC) materials, such as posters, brochures, flyers, and papercraft, were collected from fisheries agencies in Japan and the Philippines. Science teachers and students evaluated the proposed projects. **Funding:** Japanese and Filipino science teachers are both innovative and creative due to the lack of materials provided by the national government. The museum is one strategy for science learning, but the results showed using ICT is lacking in the proposed innovations. Integrating arts and other concepts is crucial in this time of pandemics and the rapid rise of technology. Thus, the use of ICT needs to improve. A collaboration between computer experts is necessary. Teaching marine education in elementary and secondary becomes interesting and exciting. The innovative approach and strategy would also answer the call of the United Nations – Sustainable Development Goals (SDGs) ”Life below Water.” **Novelty**: The uniqueness of the results showed that the proposed innovations have the potential to increase awareness of the significance of marine biodiversity to other living things. Also, with the pandemic, science courses are one of the subjects greatly affected due to no contact with learners, and laboratory activities were on hold.

Keywords: Marine Education; Museum; Instructional Materials; Local Resources; Museum; Visual Aids

1 Introduction

Instructional materials are important in science teaching and learning. In one study, the use of instructional materials in learning natural science showed positive effects on the academic performance of learners. Also, literacy skills have a great impact on a scientific approach that enhances the academic achievements of learners in terms of knowledge, attitudes, and science process skills of students[(1)]. In addition, it was confirmed by another study that students performed significantly better with instructional materials. Also, the use of teaching materials improved the understanding of concepts and academic performance. Thus, teaching and learning computers required various instructional materials[(2)]. The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) of Japan and the Department of Education (DepEd) of the Philippines encourage teachers to use instructional materials in various pedagogical engagements. Japan and the Philippines are very opposite in terms of instructional materials. Japan has state-of-the-art facilities, while the Philippines have limited resources[(3)].

Education is not limited to the four corners of the classroom. Many education systems around the world conduct field trips to various educational institutions like museums, botanical gardens, and zoos to enhance teaching and learning. Going to institutions that showcase vast collected works, artifacts, and culture can enrich the minds of any age. The depth of experiences provided by the museum is crucial to learners[(4)]. Museum today serves as alternative learning material in all subjects. The museum is one of the best resources to learn science efficiently and accurately. In museums, learners can understand intricate scientific concepts in a vet easy and accessible way. In addition, museums improved inquiry-based learning among students[(5)]. To make museums effective materials for learning, support is the key factor. Further, the study showed that the proper design and content of the museum as educational support is needed. Thus, studies during COVID-19 about online museums were suggested. But the results of the study suggested proper utilization for effective application is required[(6)]. Hence, museums serve as knowledge supplementation for learners. A partnership between schools and museums is crucial for learning[(7)].

In the science curriculum, instructional materials like textbooks, lesson plans, activity sheets, and laboratory equipment support instruction and are significant resources – they improve education. In Japan, all materials are free, but in the Philippines, DepEd is struggling to provide free learning materials due to a lack of funds, and many textbooks are erroneous or have plenty of errors. These human and non-human materials strengthen learners' knowledge, abilities, and learning. Science is significant to learners if lessons relate to everyday situations. Both genders have a higher level of participation in science lessons if hands-on practical tasks are incorporated effectively. Despite that, active learning is time-consuming compared to the traditional approach but always positively impacts learners[(8)]. Each country creates innovations and policies to cope with rapid technological changes and other current trends. Active learning is a way to potentiate learning because it makes peer interaction[(9)]. Active learning in Japan is evident in their in-service training for teachers or in Lesson Study. Science teachers in the Philippines are trying to implement it but still fail.

Additionally, the concept of using creativity focused on incorporating arts in materials displayed in the museum is one of the plans of this study. For many decades, visual aids have positively impacted teachers and students. Teachers utilize different approaches for students' active learning. Visual aids are devices for easy and exciting learning. Also, arts-integrated into science help students improve reading and

remember science concepts effectively. Furthermore, using arts in science promotes transferable knowledge and skills connecting all disciplines [10]. These outputs should be displayed in areas like museums as learning materials. Thus, this study is unique because there were very few schools that had museum-like facilities inside the campuses.

Likewise, this study is anchored on sustainable development goals (SDG) 4 and 14. SGD4 is about Quality Education and SDG 14 talks about Life Below Water. Quality Education is important for a sustainable education system but focused on protecting marine biodiversity. Also, Life under Water was utilized to highlight some projects and programs for ocean literacy in the education system in both countries [11,12]. Since Japan and the Philippines are archipelagoes, and marine resources are bountiful; it is crucial to enhance marine education in basic education curricula through innovations.

In the science curriculum in basic education in Japan and the Philippines, marine education is a major part of the lessons. The current environmental condition is alarming. Thus, the researchers were motivated to engage in this concept to help restore marine resources. Marine education is one of the subject areas affected by the pandemic. One study recommended a catch-up framework. This innovation will help students to cope with the current situation like online learning [13]. As a result, marine education is effective in 3rd graders by using museums as instructional materials for marine education [14]. There were very few marine science museums in both countries. These innovations suggest creating a marine museum in schools near the coastal areas to preserve and protect marine biodiversity. One study mentioned initiating to bridge the gap in the marine collection for awareness and directory purposes [15].

The two counties' science classrooms and laboratories showcase preserved marine resources. But none of these countries utilizes museums as instructional materials in teaching science curricula specifically marine education. Hence, this study's primary purpose was to create a marine museum as instructional materials in the science curriculum in Japan and the Philippines.

2 Methods

2.1 Research Design

This study used a quantitative-qualitative developmental-descriptive-narrative (Focus Group Discussion) research design that focused on developing museum-like Information, Education, and Communication (IEC) Materials as instructional material in the teaching-learning process of biodiversity. The research focused on collecting materials as long as there are concepts and ideas of Japanese and Filipino marine resources. Developmental design is about creating more visual aids for museum displays.

2.2 Research Methods

The method employed is archival inquiry and aesthetic interpretation. In the archival inquiry, relevant materials were identified by the researchers as the major part of the study. Many of the documents gathered were previously published and are still available from the centers and agencies. At the same time, aesthetic interpretation is about interpreting the visual presentation of the collected materials. All the materials collected were from visited agencies and departments, science marine activities, exhibits, museums, thrift shops, and internet websites of Japan and the Philippines.

Specifically, the researchers visited various marine museums, centers, exhibits, and conferences. Five science experts were tapped to help evaluate and assess the collected materials as possible resources for the museum. Personal judgment was used to analyze all collected documents from various sources. The materials gathered, such as printed, electronic, graphics, audio-visual, Information, Education, and Communication (IEC), were evaluated based on their authenticity, credibility, representatives, and meaning. Also, artists were invited to create different instructional materials. The IEC was used by teacher-facilitators in the Philippines and Japan in their classes in Marine Biodiversity. The materials were evaluated by students and teacher-facilitators using a researcher-made questionnaire for innovation dimensions. The IEC was assessed using a questionnaire checklist and Focus Group Discussion (FGD) to attain the respondents' feedback.

2.3 Respondents of the Study

The respondents of this study were purposively and conveniently selected 517 teacher-facilitators and students from Philippine Schools and 155 teacher-facilitators and students from Japanese Schools. The frequency and distribution of the respondents are as follows:

Table 1. Frequency of the Respondents from the Philippines and Japan

Respondents		N	%
Philippines	Teacher-Facilitators	25	4.8
	Students	492	95.2
	Total	**517**	**100.0**
Japan	Teacher-Facilitators	25	16.1
	Students	130	83.9
	Total	**155**	**100.0**

Table 2. Distribution of the Respondents according to level

Respondents		N	%
Philippines	College Faculty	3	.6
	SHS Faculty	4	.8
	JHS Faculty	6	1.2
	Elementary Faculty	12	2.3
	College Students	12	2.3
	SHS Students	80	15.5
	JHS Students	80	15.5
	Elementary Students	320	61.9
	Total	**517**	**100.0**
Japan	College Faculty	3	1.9
	SHS Faculty	4	2.6
	JHS Faculty	6	3.9
	Elementary Faculty	12	7.7
	Undergraduate (Gakushi-katei) Students	10	6.5
	SHS (Kotogakko) Students	30	19.4
	JHS (Chugakko) Students	30	19.4
	Elementary (Shogakko) Students	60	38.7
	Total	**155**	**100.0**
Grand Total		**672**	

Legend: Highly Innovative (4.21-5.00); Very Innovative (3.41-4.20); Innovative (2.61-3.40); Moderately Innovative (1.81-2.60); Needs Improvement (1.00-1.80)

2.4 Instructional Materials Used as Museum Display

Figure 1 shows the different proposed instructional materials to be displayed in a museum.

The national government in the Philippines is always working with education to convey messages to improve various natural resources. For the past decades, these government agencies, with their satellite offices, distributed materials like posters, brochures, flyers, and many more to inform the public about our natural resources and current status. But to convey the visions of these IEC materials, the education sector must be the priority. Train teachers on using these materials for different lessons. IEC is a form of printed materials to promote desired and positive behaviors among stakeholders. IEC materials are info and approaches to inspire people to join the agency's program and project. This coloring activity for kids can be used as a resource for managing and identifying life forms in the ocean.

Also, coloring activities for kids can be used as a resource for managing and identifying life forms in the ocean. Coloring the organisms can help learners distinguish unique, essential features of flora and fauna found in the sea. Engaging students in instructional practices develop complex reasoning abilities. One of Japan's fisheries centers is to make awareness about their advocacy. Resources are found helpful in creating the marine museum.

Japanese is known for origami. Instead of making flowers, the marine agency decided to make materials from different ocean animals found in Japanese water. The materials were distributed during ocean week around Japan. This activity is exciting, and kids love it. This paper activity allows learners to play and explore. Origami enhanced mathematical and vocabulary skills. Thus,

this activity could help learners improve complex concepts and ideas in science pedagogy. A three-dimensional replication of animals is crafted and can help students see the actual pictures of fishes, turtles, squids, etc.

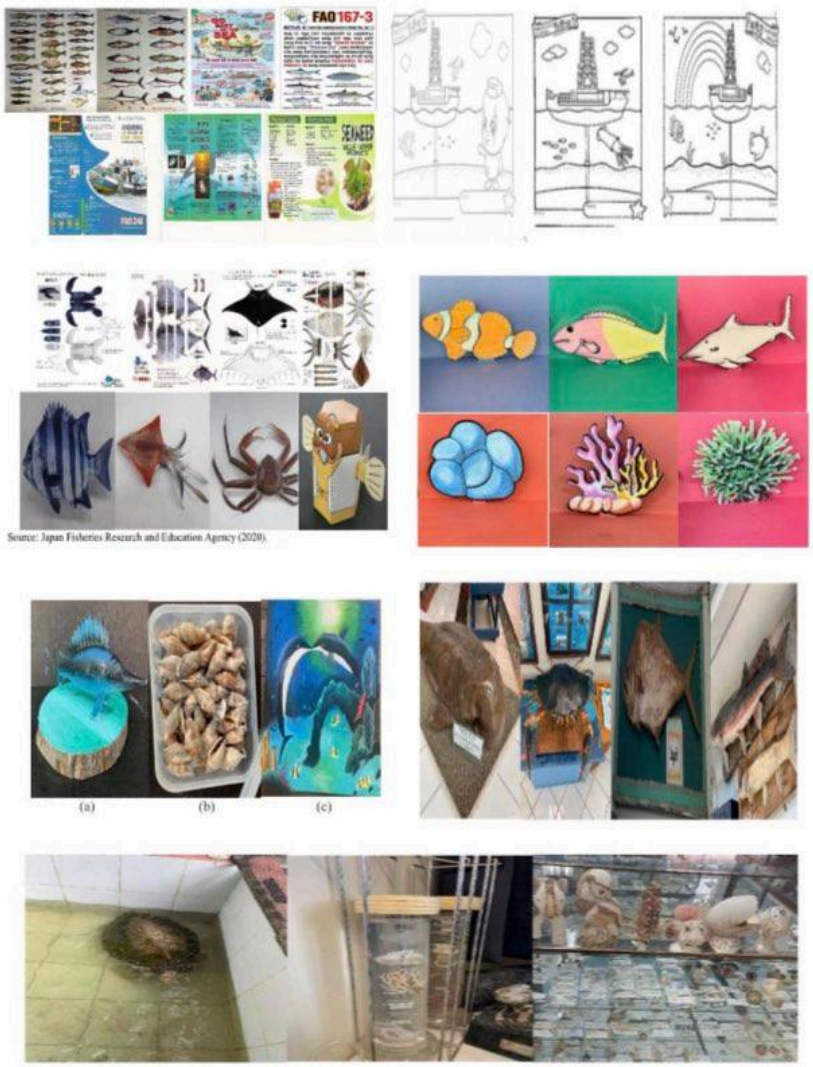

Fig 1. Proposed instructional materials inside the museum

These innovations can give an alternative to the required state-of-the-art. However, alternative methods are recommended in countries like the Philippines, which are still struggling to provide science facilities.

Arts play a significant part in all collected materials. Science alone cannot enhance mental and physical development, but growth and progress will occur with art integration. Thus, science, technology, engineering, and mathematics incorporate arts, now called STEAM. STEAM-based education aims to help learners become innovative and creative and enhance critical thinking. Additionally, arts improve cooperation and enrich communication skills. Emerging approaches for decades, STEAM as a movement brings about innovations in science pedagogy. STEM as a course needs to be designed to eradicate notions by many that it is a complicated subject matter. Education departments in each country improve science curricula through emerging trends and strategies.

There are many techniques used in preserving specimens. They painted the sample before filled with formalin inside the jar. This process can help the varieties to stand for years.

2.5 Data Analysis

This study utilized mean and standard deviation to assess the respondents' quantitative feedback. It was described and interpreted using a 5-point arbitrary Likert scale. Further, this used a Focus Group Discussion (FGD) to attain feedback from teacher-facilitators and students from the Philippines and Japan.

3 Results and Discussion

Table 3 shows the assessment of the innovation dimension for IEC materials from Philippine schools.

Table 3. Assessment of innovation dimensions for IEC Materials from Philippine Schools

Innovation Dimension	N	Std. Deviation	Mean	Description
Teacher-Facilitators				
Learning Objectives	25	0.3317	4.88	Highly Innovative
Teachers' Roles	25	0.0000	5.00	Highly Innovative
Students Roles	25	0.5066	4.44	Highly Innovative
ICT Used	25	0.0000	2.00	Moderately Innovative
Connectedness	25	0.3742	4.84	Highly Innovative
A multiplicity of Learning Outcomes	25	0.3317	4.88	Highly Innovative
Overall-Innovation Dimension	25	0.1481	4.34	Highly Innovative
Students				
Learning Objectives	492	0.3299	4.88	Highly Innovative
Teachers' Roles	492	0.3675	4.84	Highly Innovative
Students' Roles	492	0.4043	4.79	Highly Innovative
ICT Used	492	0.3129	1.89	Moderately Innovative
Connectedness	492	0.4087	4.79	Highly Innovative
Multiplicity of Learning Outcomes	492	0.5297	4.75	Highly Innovative
Overall-Innovation Dimension	492	0.2026	4.32	Highly Innovative
Total				Moderately Innovative
Learning Objectives	517	0.3297	4.88	Highly Innovative
Teachers' Roles	517	0.3602	4.85	Highly Innovative
Students Roles	517	0.4163	4.78	Highly Innovative
ICT Used	517	0.3061	1.90	Moderately Innovative
Connectedness	517	0.4069	4.79	Highly Innovative
A multiplicity of Learning Outcomes	517	0.5223	4.76	Highly Innovative
Overall-Innovation Dimension	517	0.2002	4.32	Highly Innovative

Legend: Highly Innovative (4.21-5.00); Very Innovative (3.41-4.20); Innovative (2.61-3.40); Moderately Innovative (1.81-2.60); Needs Improvement (1.00-1.80)

In the Philippines, the results showed that all categories were "Highly Innovative" except for ICT Used, which was "Moderately Innovative."

In the study of the role of ICT in teaching, science is considered a discipline, resource, and critical. Thus, the DepEd wanted to improve the use of computers, other gadgets, and even connectivity to make science teaching and learning science effective in the entire archipelago. They even allocated a large amount for the purchase of laptops. This concept was already included in the implementation of the K12 Basic Education Program.

Table 4 assesses innovation dimensions for IEC materials from Japanese schools.

Similar to the Philippines, ICT used for teachers and students "Needs Improvements," and the overall-innovation dimensions were "Very Innovative" in Japan.

In terms of learning outcomes, more school teachers are providing easy-to-understand instructions for children using ICT tools and successfully conducting classes to assist children in extending and deepening their thought processes through ICT [16]. Hence, incorporating ICT in a marine science museum as instructional materials in the science curriculum would be easy for teachers.

Table 4. Assessment of innovation dimensions for IEC Materials from Japanese Schools

Innovation Dimensions		N	Std. Deviation	Mean	Description
Teacher-Facilitators					
	Learning Objectives	25	0.5000	4.60	Highly Innovative
	Teachers' Roles	25	0.5066	4.56	Highly Innovative
	Students' Roles	25	0.5066	4.44	Highly Innovative
	ICT Used	25	0.5066	1.44	Needs Improvement
	Connectedness	25	0.5099	4.48	Highly Innovative
	Multiplicity of Learning Outcomes	25	0.4899	4.64	Highly Innovative
	Overall - Innovation Dimension	25	0.2531	4.03	Very Innovative
Students					
	Learning Objectives	130	0.3695	4.84	Highly Innovative
	Teachers' Roles	130	0.3831	4.82	Highly Innovative
	Students' Roles	130	0.4324	4.75	Highly Innovative
	ICT Used	130	0.4981	1.44	Needs Improvement
	Connectedness	130	0.4278	4.76	Highly Innovative
	Multiplicity of Learning Outcomes	130	0.6043	4.66	Highly Innovative
	Overall - Innovation Dimension	130	0.2429	4.21	Highly Innovative
Total					
	Learning Objectives	155	0.4013	4.80	Highly Innovative
	Teachers' Roles	155	0.4152	4.78	Highly Innovative
	Students' Roles	155	0.4583	4.70	Highly Innovative
	ICT Used	155	0.4978	1.44	Needs Improvement
	Connectedness	155	0.4523	4.72	Highly Innovative
	Multiplicity of Learning Outcomes	155	0.5860	4.66	Highly Innovative
	Overall - Innovation Dimension	155	0.2532	4.18	Very Innovative

Legend: Highly Innovative (4.21-5.00); Very Innovative (3.41-4.20); Innovative (2.61-3.40); Moderately Innovative (1.81-2.60); Needs Improvement (1.00-1.80)

The study's results revealed that the main contribution understands that using ICT in science education is not an isolated action without a theoretical basis. The use of ICT is still planned and supported by traditional academic trends in teaching, learning, knowledge, and curriculum design [17]. The study about using ICT in Science teaching showed consistency with the student's tendencies and attitudes. Also, it enhances the construction of educational content based on the constructivist theory of learning and provides social learning environment.

Table 5 shows the feedback from teacher-facilitators on the use of IEC materials.

Regarding various categories in teachers' evaluation in Japan and the Philippines, the respondents positively responded to the IEC materials as resources for science teaching.

The basic science curriculum of Japan and the Philippines contains lessons about marine biodiversity, evident in the Course of Study in Japan and the Science Curriculum Guide in the Philippines. Illustrations of marine flora and fauna are also found in some science textbooks in both countries. Marine flora and fauna are not the main topics. However, Japan and the Philippines advocate contextualization and localization; thus, schools located within coastal areas can incorporate local marine resources into the lessons. But MEXT and DepEd should re-evaluate the science curriculum to answer one of the Sustainable Development Goals (SDGs) of the United Nations: "life below water." This goal aims to protect and preserve the marine ecosystem. The marine ecosystem's current situation is alarming; many flora and fauna are now extinct - educating young generations on how to protect and preserve these resources is the solution to the problems. The SDG agenda's attainment depends on collaborations among various stakeholders. Member countries of the United Nations, Japan, and the Philippines should help achieve the plan in 2030 [11,12].

Table 5. Feedback from teacher-facilitators on the use of proposed instructional materials

Teacher's Evaluation	PHILIPPINES	JAPAN
Creative and Innovation	They were positively overwhelmed, not only by the student's reactions. It was very easy for teachers to teach and convey information on marine biodiversity to the students through an interactive classroom innovation.	It was simple yet creative. This method brings interaction between teachers and students.
Research and Information Fluency	Students were interested in the Visayan Sea's different species of marine life.	The feed of spontaneous information to students through interaction and reading in labels
Critical thinking, development of problem-solving, and decision-making skills	Students asked their teacher-facilitators several higher-order thinking skill (HOTS) questions, and it was easy for them to answer questions and detail facts.	The students develop critical thinking of students through questions and answers.
Independent Learner	Students tend to be explorative by merely handling dried or replica specimens. They tend to ask questions of causality, e.g., environmental effects on the diversity of marine species, ecological degradation, and destructive human activities. Most of the students interact with themselves.	Most students return or go to the displays independently and read labels. It adds to curiosity and independence in the learning of students
Responsible Environmental Citizenship	Students tend to ask questions of causality, e.g., environmental effects on the diversity of marine species, ecological degradation, and destructive human activities.	Concepts in the exploration of marine biodiversity add to learners' ecological awareness.
Technology Operation and Concepts	Although museums' operations and concepts are old-fashioned, they are very effective and integrated into a classroom setting.	The concept is excellent and informative. It lacks integration of technology for a more interactive, easy, and advanced way of learning processes
Effective Communication	Based on formative and summative assessments given to the students, it is an effective means of learning, an interactive tool, and communication in general.	It induces communication between students and teachers.

The Science curriculum is an essential factor in societal development in both countries. Science teaching and learning is fun and exciting; having instructional materials that allow students to be active in learning—using instructional materials in Phyinfluenceences the teaching and learning process. There is also a significant increase in learners' performance with enough instructional materials compared to traditional approaches. Thus, teachers should innovate if no instructional materials are available because it enhances students' performances [3].

Table 6 shows the feedback from a student on the use of IEC materials.

Table 6. Feedback from students on the use of proposed instructional materials

Students' Evaluation	PHILIPPINES	JAPAN
Creative and Innovation	The students enjoyed the discussion on marine biodiversity in the context of the Visayan Sea.	The students had fun in the showcase of different marine species in class. Replica of the species makes them imagine the real/ animals in the marine ecosystem
Research and Information Fluency	They explored the richness of the Visayan Sea without leaving the corners of their school with complete and detailed literature and brochures of marine biodiversity.	The students explored marine biodiversity in class through a museum-like setup. It makes them read the signages and works of literature annexed to the replica.

Continued on next page

Table 6 continued

Critical thinking, development of problem-solving, and decision-making skills	Students tend to think outside the box and ask relevant questions about biodiversity and its effects on the ecosystem. They enjoyed the artworks and displays, especially the dried specimen.	Students gave several questions; answers were available and annexed to the replica.
Independent Learner	They thoroughly talked with their classmates about whether they saw the species on their home island or the coastal areas.	It makes the students go to each specimen and explore its content.
Responsible Environmental Citizenship	Students raise questions like environmental effects on the diversity of marine species, ecological degradation, and destructive human activities.	Gave the students ideas on the do and didn't to preserve the marine ecosystem.
Technology Operation and Concepts	A new concept in the learning experience	No use of computers or other tech devices for a more exciting delivery of ideas
Effective Communication	The discussion was informative and effective in giving information to the students.	More interaction between students and teachers was used to use visual aids (museum-like learning tools).

The museum is an opportunity to enhance students' knowledge and motivation in science. The elementary and secondary students gained content knowledge recall and science motivation by joining informal science learning like a museum. Science museums are not only for children but for adults as well. Museum displays involved natural specimens and scientific models. The display must convey scientifically relevant relationships with the themes, materials, and visitors. The concept of interactive approaches is always available in the museum. The Science Museum allows children to manipulate equipment and facilities on current blended learning. But the social norms and attitudes of the people about the museum are relevant to policies and procedures; hence, embracing an inclusive mindset is necessary [18].

Visiting the museum has a significant impact on guests learning oriented-experiences. Visitors always link fun and learning in museum appointments. There are different reasons teachers use museums for education. Outdoor learning, like museums, gives different experiences for children. For instance, manipulating artifacts retained learning. Also, most elementary and secondary teachers respond positively to using the museum in pedagogy. Teachers believe the museum inspires all learners [19]. Also, visiting the museum can improve critical thinking skills and questioning that later can enhance communication abilities. Also, children who attend the museum are exposed to new concepts and ideas that inspire them to wonder.

Additionally, students' bare museum activities develop creativity and lifelong learning. A trip to the museums allows children to speak freely. Children can construct a query base on the observation inside the museum. The conversation with parents or companions starts children's curiosity to ask more questions. The museum can always create its brand [20]; in this study, the brand is a museum of local marine resources as instructional materials in the science curriculum in Japan and the Philippines.

Projects about marine resources are popular in elementary schools. This activity promotes understanding scientific concepts and teaches science as a body of knowledge. Thus, the study suggests strong collaboration between elementary schools and museums as educational projects. Moreover, science literacy is achieved both in school and out-of-school settings; therefore, the Museu Nacional de História Natural e da Ciência provides realistic experiences for scientific concepts. This innovation enhances citizens' awareness of geological heritage [21].

The museum can allow learners to explore independently with the supervision of staff or teachers. In the study about active learning, teachers, and students favored the approach because it positively affects all courses. Active learning allows students to learn through hands-on activities and discuss the findings or results in front of the class. Active learning offers meaningful academic activities. Also, active learning is embedded in the training program and is useful in increasing logical thinking. Thus, using museums containing colorful and exciting materials arouses curiosity among students. But allowing students to create their ideas and concepts of the marine ecosystem before and in current situations also develops critical thinking and actively creates their images and pictures. Also, the strategy will allow students to be free without pressure in learning science lessons [6].

However, students' performance on a field trip to the museum has a negligible effect on science test scores and proficiency. Thus, various training and enhancement among science teachers are required. The use of activities like a museum visit needs orientation properly among the implementer. Teachers must have enough knowledge and skills to use the museum to increase science performances. There is an expert named curator in the aquarium. It is essential to collaborate between them and teachers [22].

In addition, the museum is a center for informal education. Learning about local marine resources is learning about one's culture and heritage. Thence, museums are invariant with schools to learn about and have materials related to heritage. Heritage,

museums, and education are intertwined [23].

4 Conclusion

The suggested innovation has great potential as instructional materials in marine education in both countries regardless of grade level. But the results recommended integrating technology to make it more effective and efficient for science pedagogy. This pandemic change the landscape of the education system around the world. Gadgets and connectivity are now essential for the education system in the new normal. The national government should support this proposal to protect and preserve local marine biodiversity. Japan and the Philippines are countries surrounded by bodies of water and marine resources. These resources are all beneficial to humanity's survival and existence. Incorporating the Museum of marine resources in science pedagogy is a strategy to make our learners become warriors to protect and preserve our marine ecosystems. This innovation is also a way to answer the call of the United Nations - sustainable goal number 14, "life below water." Thus, the results of the study can also contribute to the success of the SGD. Further studies are recommended to evaluate the proposed instructional materials to be displayed inside the museum through action research.

References

1) Asrizal A, Amran A, Ananda A, Festiyed F. Effects of instructional material of natural science with literacy skills of our respiratory and excretory health theme on academic achievement of students. In: The 3rd International Conference on Mathematics, Sciences, Education, and Technology , 4–5 October 2018, Padang, Indonesia;vol. 1317 of Journal of Physics: Conference Series,. IOP Publishing. 2019;p. 1–7. Available from: https://iopscience.iop.org/article/10.1088/1742-6596/1317/1/012174/pdf.
2) Umar H, Kyarma HM, Buratni MA. Effectiveness Use of Instructional Materials in Teaching and Learning of Computer Science in Colleges of Education. *International Journal of Interdisciplinary Research and Innovations*. 2019;7(4):59–65. Available from: https://www.researchpublish.com/upload/book/EFFECTIVENESS%20USE%20OF%20INSTRUCTIONAL-8133.pdf.
3) Peniero TF, Toshihiko M. Science teaching and learning in Japan and the Philippines: A comparative study. *Universal Journal of Educational Research*. 2020;8(4):1237–1245. Available from: https://www.hrpub.org/download/20200330/UJER14-19515076.pdf.
4) Role of Museums in Education - Why Museums are Still Relevant to Education. 2023. Available from: https://www.stevenson.edu/online/about-us/news/role-of-museums-education/.
5) The Effectiveness of Science Museums as Educational Institutions. 2022. Available from: https://www.arnabontempsmuseum.com/the-effectiveness-of-science-museums-as-educational-institutions/.
6) Milutinović J, Selaković K. Pedagogical Potential of Online Museum Learning Resources. *Journal of Elementary Education*. 2022;15(Spec. Iss.):131–145. Available from: https://doi.org/10.18690/rei.15.Spec.Iss.131-145.2022.
7) Doctors E. Museum-School Partnerships: From Creative Discourse to Resource Development. San Francisco, USA. 2018. Available from: https://repository.usfca.edu/capstone/879.
8) Aji CA, Khan MJ. The Impact of Active Learning on Students' Academic Performance. *Open Journal of Social Sciences*. 2019;07(03):204–211. Available from: https://doi.org/10.4236/jss.2019.73017.
9) Marin RAT, Espinoza BLA. Non-Formal Education as a Foundation for Active Learning. In: Lutsenko O, Lutsenko G, editors. Active Learning - Theory and Practice. 2021. Available from: https://www.intechopen.com/chapters/75088.
10) Hardiman MM, Johnbull RM, Carran DT, Shelton A. The effects of arts-integrated instruction on memory for science content. *Trends in Neuroscience and Education*. 2019;14:25–32. Available from: https://doi.org/10.1016/j.tine.2019.02.002.
11) Ferreira JC, Vasconcelos L, Monteiro R, Silva FZ, Duarte CM, Ferreira FC. Ocean Literacy to Promote Sustainable Development Goals and Agenda 2030 in Coastal Communities. *Education Sciences*. 2021;11(2):1–21. Available from: https://doi.org/10.3390/educsci11020062.
12) Saini M, Sengupta E, Singh M, Singh H, Singh J. Sustainable Development Goal for Quality Education (SDG 4): A study on SDG 4 to extract the pattern of association among the indicators of SDG 4 employing a genetic algorithm. *Education and Information Technologies*. 2023;28(2):2031–2069. Available from: https://doi.org/10.1007/s10639-022-11265-4.
13) Ochavillo GS. A Paradigm Shift of Learning in Maritime Education amidst COVID-19 Pandemic. *International Journal of Higher Education*. 2020;9(6):164–177. Available from: https://files.eric.ed.gov/fulltext/EJ1277930.pdf.
14) Lai CS. A Study of the Learning Outcomes on Marine Education. *International Journal on Social and Education Sciences*. 2021;3(3):589–602. Available from: https://doi.org/10.46328/ijonses.218.
15) Collins JE, Rabone M, Vanagt T, Amon DJ, Gobin J, Huys I. Strengthening the global network for sharing of marine biological collections: recommendations for a new agreement for biodiversity beyond national jurisdiction. *ICES Journal of Marine Science*. 2021;78(1):305–314. Available from: https://doi.org/10.1093/icesjms/fsaa227.
16) Ovigli D, Colombo PD. Information and communication technologies (ict) in educational research in science museums in Brazil. *International Journal of Education and Development using Information and Communication Technology*. 2020;16(2):272–286. Available from: https://files.eric.ed.gov/fulltext/EJ1268774.pdf.
17) Fernandes GWR, Rodrigues AM, Ferreira CAR. Different Theoretical Approaches to the Use of ICT in Science Education. In: Using ICT in Inquiry-Based Science Education. SpringerBriefs in Education. 2019;p. 39–58. Available from: https://doi.org/10.1007/978-3-030-17895-6_2.
18) Jee BD, Anggoro FK. Designing Exhibits to Support Relational Learning in a Science Museum. *Frontiers in Psychology*. 2021;12:1–9. Available from: https://doi.org/10.3389/fpsyg.2021.636030.
19) Bradford L, Diaz A, Schilling R. Expanding Museum Communities: International Perspectives on Access in Exhibition Design and Public Programs. *Journal of Museum Education*. 2021;46(1):38–47. Available from: https://doi.org/10.1080/10598650.2020.1842624.
20) Rodrigues J, Silva ECE, Pereira DI. How Can Geoscience Communication Foster Public Engagement with Geoconservation? *Geoheritage*. 2023;15(1):1–15. Available from: https://doi.org/10.1007/s12371-023-00800-5.

21) Al-Anabi WAARA, Al-Thallab SHA. The effectiveness of a training program based on active learning strategies among students of the College of Basic Education and their logical thinking. *Psychology and Education*. 2021;58(1):4318–4326. Available from: https://doi.org/10.17762/pae.v58i1.1509.
22) Munirah A. Museums as Learning Spaces: A Case Study of Enhancing ESP Students Language Skills in Kuwait University. *English Language Teaching*. 2021;14(2):1–8. Available from: https://files.eric.ed.gov/fulltext/EJ1284441.pdf.
23) Monteagudo-Fernández J, Gómez-Carrasco CJ, Chaparro-Sainz A. Heritage Education and Research in Museums. Conceptual, Intellectual and Social Structure within a Knowledge Domain (2000–2019). *Sustainability* . 2021;13(12):1–21. Available from: https://doi.org/10.3390/su13126667.